PRACTICAL ENGINEER

Trade-mark reg. U. S. Pat. Office

SEMI-MONTHLY

VOL. XVIII. CHICAGO, MARCH 15, 1914 No. 6

Holland City Municipal Plants

LOW PRICE CHARGED CUSTOMERS DUE TO EFFICIENT MANAGEMENT. RECORDS KEPT AND SUMMARY OF COSTS. BY R. B. CHAMPION

THE HOLLAND CITY WATER WORKS has been owned and operated, since its inception in 1883, by the municipality. Through the years which have followed, the system has kept step with the growth of the city until today it represents a total investment of more than $230,000. In 1895 the city purchased from a private company the electric light plant, which furnishes the power for pumping and street lighting as well as for commercial purposes. The first and second bond issues, to cover the initial purchase of the plant, amounted $24,000, subsequent issues bringing the total bond issue up to $91,000. Of this amount $39,000 has been paid, leaving the present bonded indebtedness at $52,000. The present plant bears very little resemblance to the original plant, except in perhaps a small portion of the building which remains; all the apparatus being of modern construction.

The construction and operation of these pumping and lighting plants are entrusted to a Board of Public Works, consisting of 5 members appointed by the Common Council. One member is appointed each year to serve a term of 5 yr., and the service is given gratis.

FIG. 1. GENERATING UNITS IN THE HOLLAND CITY MUNICIPAL PLANT

The same Board also has charge of the construction and operation of the sanitary sewers, and fire alarm system. From 1895, the year the Board was created, to 1913, 16 men served as members, giving an average term of service of 5 yr., although individual periods of service ran to 16, 13, 10 and 8 yr. each. The Board appoints a superintendent of public works, who serves during the pleasure of the Board.

Power Plant Equipment

Current is generated at 2400 volts, 2-phase, 60-cycle. The present generating equipment consists of a 500-kv.a. Allis-Chalmers steam turbine, a 300-kv.a. Westinghouse generator direct connected to a Russell cross compound automatic condensing engine, and a 1000-kw.

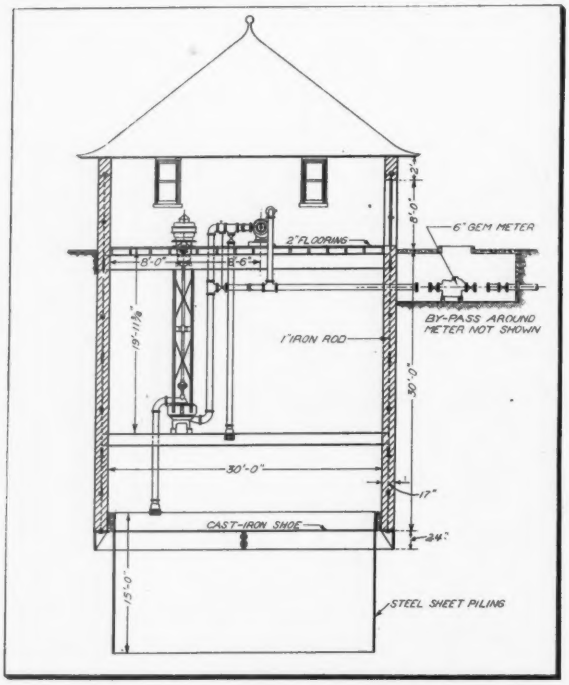


FIG. 2. SECTIONAL ELEVATION OF THE 21ST STREET PUMPING STATION

Allis-Chalmers steam turbine, built for 80 per cent power factor. For the 500-kw. unit a jet condenser is used, operated by a direct-connected, 40-hp., Allis-Chalmers, 2200-v., squirrel-cage induction motor. Vacuum is furnished the engine-driven generator by a steam-operated jet condenser. For the 1000-kw. turbine, a Worthington 4000-sq. ft. surface condenser is used, having as auxiliaries a Worthington 2-in. turbine hot-well pump, direct connected to a Terry steam turbine and a Worthington dry vacuum pump, type B, size 10 by 18 by 10 in. The circulating pump is a 12-in. Worthington volute centrifugal, direct connected to a Worthington type B, 18 by 8 by 7-in. vertical steam engine.

Excitation for the 500-kw. unit is furnished by a 15-kw. Bullock generator, running at 600 r.p.m., and direct connected to a type E American blower 5 by 5-in. steam engine. The exciter for the 300-kw. machine is an 11¼-kw. generator belted to a squirrel-cage induction motor. The exciter for the 1000-kw. machine is mounted on the turbine shaft and runs at 3600 r.p.m. Both the steam turbines run at 3600 r.p.m.

Switchboard panels are as follows: 2 exciter, 3 generator, 1 totalizing, 4 single-phase feeder, 3 2-phase feeder, and 2 2-circuit arc. The switchboard is of blue Vermont marble, 2 in. thick, each panel being in 2 slabs, the overall dimensions being 90 by 24 in. The board stands away from the wall 7 ft., no apparatus of any kind being allowed between the board and the wall, giving ample working space in the rear of the board. The single-phase light feeders are regulated by Westinghouse step type hand regulators, constant voltage being maintained on the bus bars by means of a Tirrell regulator.

Steam is furnished by 4 300-hp. Stirling water-tube boilers, hand fired. The boiler room pumping equipment consists of 3 pumps, all interconnected so that any one pump may be used as a boiler feed pump or heater feed pump as desired. The feed-water heater is of the open type.

Coal is delivered to the plant in hopper cars and is dumped into a concrete bin adjacent the plant. The bin is divided into 5 divisions by reason of the piers supporting the railroad track. The entire bin has a capacity, when full, of approximately 85,800 tons. The coal bin floor is several feet below the boiler room floor. The coal is taken to the boiler room by means of 5 1-ton trucks, hoisted up an inclined track by means of a motor-driven hoisting drum.

Cold air for ventilating the turbine-driven generators is taken from outdoors through sheet-iron conduits, the air passing from beneath up through the generator and out through the roof through a conduit running straight up from the top of the generators.

Employes and Records

Attendance at the plant is divided into 3 watches of 8 hr. each, there being on each watch one engineer and one fireman, and on the day watch one coal passer. Each man has one day off a week, which requires the employment of a relief engineer who works 3 days as engineer and 3 days as fireman, the coal passer having his day off on Sunday of each week. In charge of the plant and of the 2 sub-pumping stations is a chief engineer.

When coal arrives at the entrance of the boiler room it passes over platform scales and each watch is charged up with the exact number of pounds of coal used in that particular watch. The average coal consumption per kilowatt-hour is 5 lb., running above or below, depending on the load on the plant and atmospheric conditions. A record of the consumption of coal is kept by means of a form, which is used in connection with an autograph register, and which is 5¾ by 6½ in. over all. As each truck load of coal arrives at the boiler room it is weighed and the number of pounds of coal entered upon the proper place on the form by the fireman. The form provides for a check of the coal consumption per watch and a recapitulation of the consumption for the day. This form is in duplicate, one copy being retained by the chief engineer, and one copy being sent daily to the stock keeper in the main office.

Lubricants, packing and miscellaneous material are kept track of on another form, which is of the same dimensions as that for the coal record, but of a different color. All goods received at the plant are entered under a heading, "Remarks," and also everything in connection with the operation of the plant, such as packing of the various machines, repairs made on any of the apparatus, and anything that is done or has happened during the day. This is also made in duplicate, one copy being retained by the chief engineer and one copy being sent to the main office.

Patrons and Services Rendered

The plant has 2296 light and 88 power consumers, all services being metered. The street lighting service consists of 199, 6:6-amp. a.c. series enclosed arc lamps. For the past few years the uniform accounting system, designed by the Railroad Commission of Wisconsin for the Wisconsin plants, has been used, the last 3 annual reports being submitted in accordance therewith, with some exceptions. Another form used in the main office is made in triplicate. Every notice given by a consumer to read a meter between the regular dates, to change the name on a bill; every complaint of poor service, of lights being out of order, of a high light or water bill, and of flat irons out of order, is entered on this form. One copy is given to the customer, as an acknowledgment of the notice given; one to the department to take care of the trouble, and one copy is retained in the office as a "follow up" to see that it is attended to promptly and in order.

The department does no wiring nor selling of electrical supplies, except lamps and flat irons. Free renewals are made in the standard sizes up to 100 watts of Gem lamps, and Mazda lamps are sold to the customer at cost, without allowance. Flat iron cord trouble is taken care of gratis by the department, also burning out of units and anything else not the fault of the consumer.

The rate charged for residence lighting is 8⅓ cents per kw.-hr., subject to a discount of 15 per cent if paid on the days specified. The commercial rate for stores is $2.50 per month per kilowatt connected plus 3 cents per kw.-hr. used, both subject to a 15 per cent discount for prompt payment. Power rates are net, running from 5 to 2 cents, depending on the amount used per horsepower per month.

All material used by the department, incoming or outgoing, is handled and checked by a stock clerk, who also attends to lamp renewals and sales of material, as well as that which is issued for the various jobs. All work of any kind, whether construction or maintenance, is accounted for by the job and reported on in unit prices. Meters are read on the 25th and 26th of each month, all employes, except the electrician and stock keeper, taking part in that work.

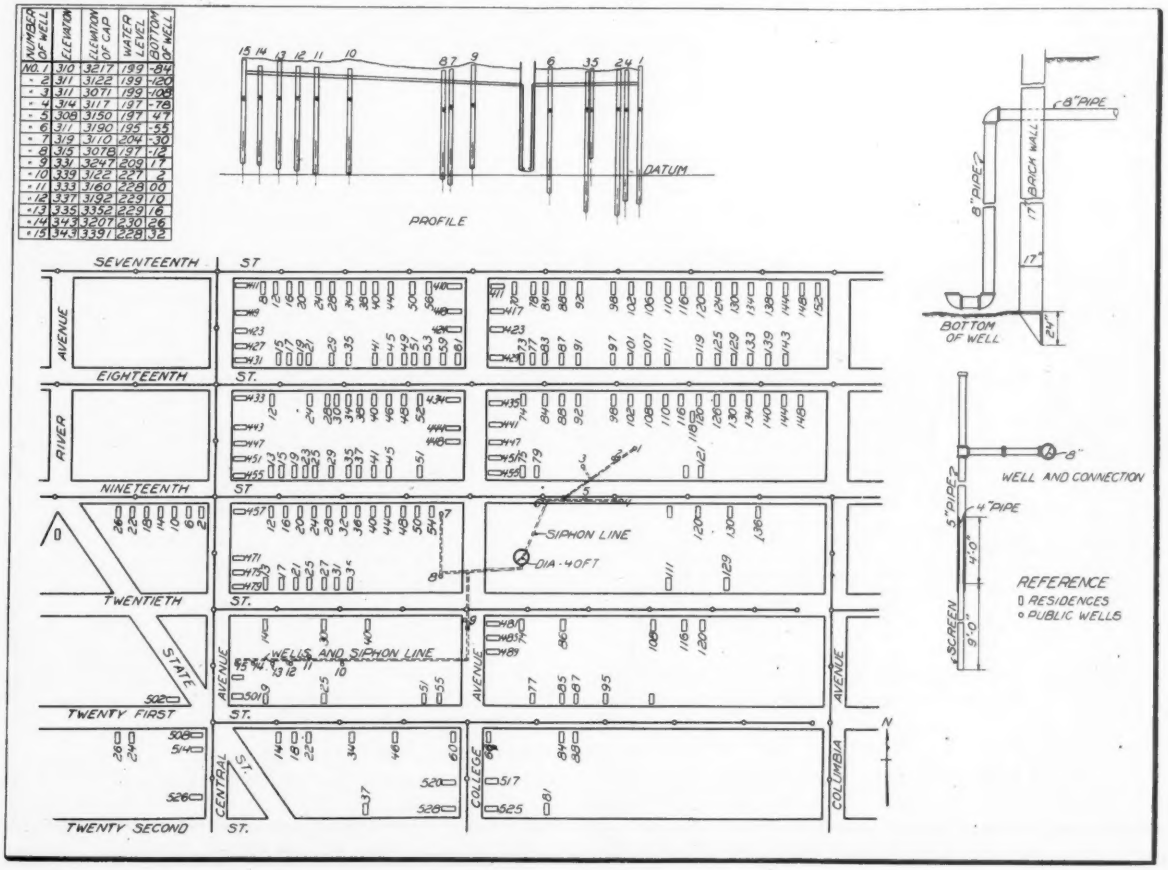


FIG. 3. PLAN OF PUMPING SYSTEM SHOWING LOCATION AND DEPTH OF WELLS AT THE 19TH STREET STATION

City Pumping Stations

The original water supply was developed at what is now the 5th Street station, which also houses the electric light plant, and was drawn from 3 open wells, 12 to 16 ft. in diameter and from 20 to 65 ft. deep. These wells were supplemented by a system of 44 2-in. drive wells. This supply has become so depleted that it is no longer used for domestic purposes, the wells being used as reservoirs from which to take water for fire purposes. The fire pump, which is located at the 5th Street station, is a Laidlaw-Dunn-Gordon duplex steam pump of 2.7 million gal. per day capacity. It is so connected that it can draw its supply from Black River in case the pure water supply becomes exhausted.

There is also at the 5th Street station a 247,000-gal. standpipe, 18 ft. in diameter and 130 ft. in height.

The present water supply is taken from a sand and gravel drift overlying clay and is supplied entirely by rainfall, the contributing water shed having an area of 1.8 sq. mi. The development is made at 2 places, the first being known as the 19th Street station and the other, as the 21st Street station.

At the 19th Street station there are 2 1050-gal. per min. single-stage American Well Works centrifugal pumps each direct connected to a General Electric 75-hp., 2200-v., slip-ring motor, each set running at 1800 r.p.m. The pumps are arranged to pump singly, in parallel or in series. When run singly, the capacity of the station is 1050 gal. per minute against domestic pressure; in parallel, 2100 gal. per minute against domestic pressure, and in series, 1050 gal. per minute against fire pressure. Although this arrangement repre-

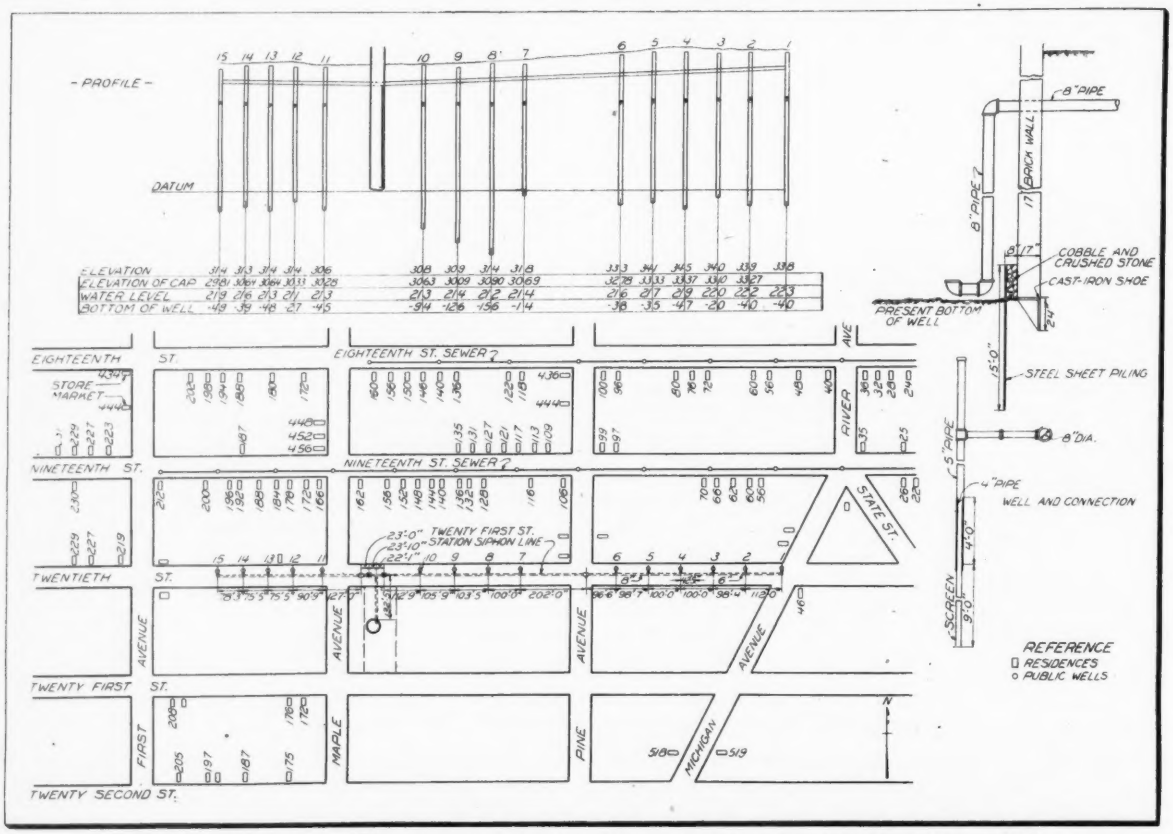


FIG. 4. LOCATION OF 21ST STREET STATION SHOWING SIPHON LINE AND DEPTH OF WELLS

When the standpipe is full the pressure is approximately 60 lb. on the mains. During normal operation the pressure is allowed to fall to 40 lb., at which point there is still left in the standpipe about 62,500 gal. The standpipe, at an alarm of fire, is shut off from the mains and may then be emptied by gravity into the suction well of the fire pump. There is, therefore, always in the standpipe a reserve pure water supply for fire which will last from ½ to 2 hr., depending upon the pressure at the time of the alarm and assuming the pump to be operated at its full rated capacity.

The fire pump is held constantly under steam pressure, and is the only water works apparatus in use at the 5th Street station.

sents the true pumping capacity of the station, the parallel connection is rarely used because during the summer, when double capacity is desirable, sufficient water is not available to supply both pumps for any appreciable length of time. The series connection has not been used at all, except for the purpose of trying it out, because since the installation the steam fire pump has, on every occasion of fire, been more than sufficient.

The pumps, which are of the horizontal type, are housed in a small, 1-story brick building, 37½ ft. by 19½ ft., and are set in a pit, located at the forward end of the building, 14 ft. 7 in. deep, with a floor space of 19½ by 14 ft. The vertical distance from the center of the pump suction to the top of the foot valve is 12 ft.

6 in. Water is pumped from a suction well 27 ft. deep and 40 ft. in diameter and so located that the horizontal length of the 10-in. suction line from the pumps is 73 ft.

Water is supplied to the suction well from a system of 15 5-in. driven wells, the water being siphoned from the driven wells to the suction well. The driven wells are of varying depth, as shown in Fig. 3, and each one is fitted at the bottom with a 4½-in. by 10-ft. Cook well strainer. The combined capacity of the system is approximately 1180 gal. per minute during the day periods of the summer.

The 21st Street station is located about 2750 ft. west and 350 ft. south of the 19th Street station. The same plan for collecting water is used at the 19th Street station, where there is one suction well 30 ft. in diameter and 30 ft. deep, which is supplemented by 15 5-in. driven wells. The arrangement is as shown in Fig. 4.

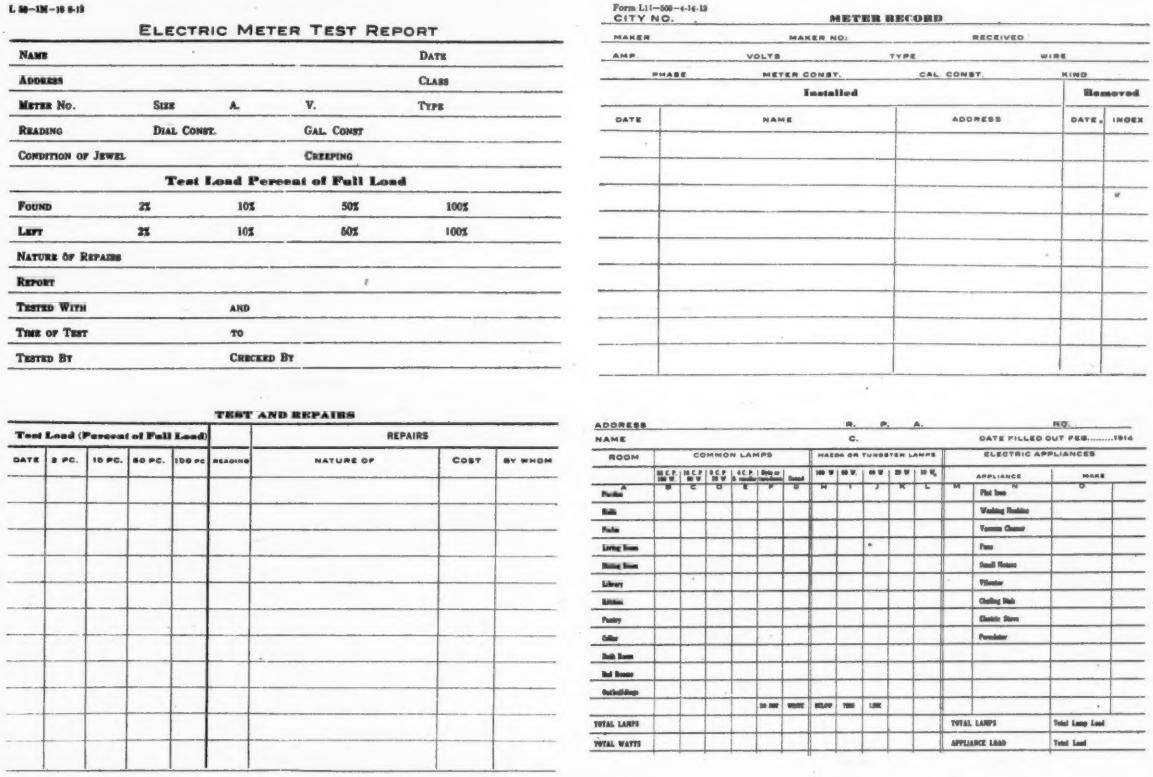
On July 21, 1913, tests were made on the driven wells to determine the yield. The 10 wells east of the open well yielded 78 gal. per minute per well while the 5 wells west of the open well yielded 126.7 gal. per minute per well.

The open well is constructed of hard brick laid in 4:1 Portland cement mortar, and was built up on a cast-iron shoe. The shelf of the shoe is 17 in. wide and the vertical blade 2 ft. long. Passing vertically through the wall from the shoe to the top plate are 33 1-in. bolts, each in 4 sections, and joined together with sleeve nuts. When each section of the bolts was set up they were held in place at the upper end by a ⅜-in. by 5-in. rolled iron template, which was left imbedded in the wall. At half-way points between the templates are 1-in. twisted iron rods laid in a groove of neat cement and encircling the vertical rods.

The well was built up in a first section of 18 vertical ft. of wall and sunk, after which the second section of 20 vertical ft. was built up and sunk. Excavation with the first section was made by means of a drag bucket, the water being kept low enough to allow workmen to operate the bucket, while wearing wading suits. During the sinking of the second section the excavation was made by pumping out the sand with a centrifugal pump, a diver being employed to move the end of the suction hose about around the entire circumference. During the sinking of the well all the machinery was carried on a platform built across the top.

The contemplated depth from grade to bottom of shoe was 40 ft., but on account of an unexpected deposit of clay under one portion of the shoe, the final depth was 8 ft. less than that contemplated.

After the station had been in operation 2 or 3 months, inflow of sand under the bottom of the shoe made necessary a caisson extending to a considerable depth below the bottom of the wall. Lackawana sheet-steel piling was put down to a depth of 9 ft. below the bottom of the shoe and the space, where the piling overlaps the wall, filled with large stones and crushed rock. This effectually shut off all further inflow.



L 80—12M—10 8-13

ELECTRIC METER TEST REPORT

NAME			DATE	
ADDRESS			CLASS	
METER NO.	SIZE	A.	V.	TYPE
READING	DIAL CONST.		GAL. CONST	
CONDITION OF JEWEL			CREEPING	
Test Load Percent of Full Load				
FOUND	2%	10%	50%	100%
LEFT	2%	10%	50%	100%
NATURE OF REPAIRS				
REPORT				
TESTED WITH		AND		
TIME OF TEST		TO		
TESTED BY		CHECKED BY		

Form L11—500—4-14-13

CITY NO.

METER RECORD

MAKER	MAKER NO.		RECEIVED
AMP	VOLTS	TYPE	WIRE
PHASE	METER CONST.	CAL. CONST.	KIND

Installed			Removed	
DATE	NAME	ADDRESS	DATE	INDEX

TEST AND REPAIRS

Test Load (Percent of Full Load)						REPAIRS		
DATE	2 PC.	10 PC.	50 PC.	100 PC.	READING	NATURE OF	COST	BY WHOM

ADDRESS R. P. A. NO.

NAME C. DATE FILLED OUT FEB. 1914

ROOM	COMMON LAMPS							HAZEM OR TUNGSTEN LAMPS					ELECTRIC APPLIANCES	
	16 C.P. 100 V.	16 C.P. 60 V.	8 C.P. 32 V.	4 C.P. 8 candle-power	Bulbs or miniature	Round	100 W.	60 W.	40 W.	25 W.	15 W.	APPLIANCE	MAKE
	B	C	D	E	F	G	H	I	J	K	L	M	N	O
Parlor												Flat Iron		
Hall												Washing Machine		
Parlor												Vacuum Cleaner		
Living Room												Fan		
Dining Room												Small Heater		
Library												Vibrator		
Kitchen												Chafing Dish		
Pantry												Electric Stove		
Cellar												Percolator		
Bath Room														
Bed Rooms														
Outbuildings														
					20 NP	WHITE	RED-PF	YEL	LBE					
TOTAL LAMPS												TOTAL LAMPS	Total Lamp Load	
TOTAL WATTS												APPLIANCE LOAD	Total Load	

FIG. 5. FORMS USED IN KEEPING TAB ON ELECTRIC METERS AND CUSTOMERS' EQUIPMENT. A. FORM USED ON THE JOB, LATER TRANSFERRED TO B AND C, WHICH ARE FRONT AND BACK OF PERMANENT CARD RECORD D. INVENTORY OF CUSTOMERS' EQUIPMENT MADE OUT EACH YEAR

The pumping equipment at the 21st Street station consists of a vertical Platt Iron Works 2-stage volute pump, direct connected to a 75-hp., General Electric, 2200-v., 2-phase, slip-ring motor, running at 1170 r.p.m. The capacity of the pump is 1100 gal. per min. against a 162-ft. head. There is also a horizontal, motor-driven centrifugal booster pump for use in pumping against fire pressure. This pump is provided with an independent suction pipe so that it may be used to keep the water down in case of trouble to the vertical pump. Four I beams, which span the center of the well on 4-ft. 6-in. centers, carry the motors and operating floor, the vertical motor being carried by 2 I beams 19 ft. below and directly beneath the center of the operating floor.

	19th Street Station			21st Street Station		
	Gallons	Kw.-hr	Kw.-hr. per 1,000 Gallons	Gallons	Kw.-hr.	Kw.-hr. per 1,000 Gallons
January ..	18,776,400	20,100	....	.....	.....	....
February..	18,189,820	17,800	....	.....	.....	....
March ...	15,277,950	15,300	1.001	.....	.....	....
April	18,541,050	18,500	0.997	.....	.....	....
May	25,288,725	25,400	1.004	.....	.....	....
June	26,040,975	27,000	1.036	11,593,600	11,900	1.031
July	16,528,575	17,000	1.028	26,875,575	28,160	1.047
August ...	25,015,200	24,700	0 987	32,020,875	31,600	0.986
September.	19,215,250	20,100	1.045	26,166,600	26,240	1.003
October...	6,105,750	6,300	1.032	16,165,000	18,160	1.123
November.	9,089,400	9,200	1.012	12,403,675	12,400	0.998
December.	9,910,350	10,000	1.009	11,559,225	12,400	1.072
Total..	207,979,445	211,400	1.011	136,784,550	140,860	1.029

W36—1M—10-15-13

Board of Public Works Retain this card for future reference

HOLLAND, MICH.

You have used water during the time between the dates shown below, as follows:

Date of Previous Reading	Previous Reading	Date of Present Reading	Present Reading	Cu Ft. Used	Cost at 6c per C	Total Cost of Water this Half Year	REMARKS

This notice is sent to you for your information and is NOT a bill. Please notify the Water Works office if you think the amount shown is larger than it should be.

LW 56—1M—9-6-13

Water Meter Repair Report

Size Make Type No.

Removed From Date

Reinstalled At Date

Reason Removed

Condition on Removal

Nature of Repairs

Meter Test

Date	1 32 in.	1-4 in.	5-8 in	3-4 in.	1 in.	Reading
Removal						
Installation						

Repaired by Passed by Hours

Form 38. 3M-2-6-'11

WATER METER RECORD

NO. SIZE MAKE

TYPE MFGR.

RECEIVED FIRST COST

INSTALLED		NAME	ADDRESS	REMOVED	
DATE	READING			DATE	READING

TEST AND REPAIRS

Date	Size of Test Stream							Repairs		
	1-32	1-4	5-8	3-4	1	11-8	2	NATURE OF	Cost	By Whom

FIG. 6. FORMS USED IN WATER WORKS DEPARTMENT. A. COMMUNICATION SENT TO CUSTOMER AFTER METER HAS BEEN READ. B. WATER METER REPAIR REPORT USED ON THE JOB, THE READINGS ARE LATER TRANSFERRED TO C AND D, WHICH ARE FRONT AND BACK RESPECTIVELY OF THE PERMANENT METER RECORD CARD

The air pump, used to take air from the siphon line to start the several wells flowing, and supplies are housed in a separate one-story brick building 10 by 12 ft. in plan. The air pump was used when the line was first completed, 30 min. being required to start the flow, but since that time the siphon action has started each day without the assistance of the air pump.

The water from both the 19th Street and the 21st Street station is measured by a 6-in. Gem meter and the electrical input by polyphase integrating meters.

Pumping Records

The following table shows the amount of water pumped, the kw.-hr. used and the kw.-hr. used per 1000 gal. Average head 150 ft.

The cost of the 19th and 21st Street stations is as follows:

	19th St. Station	21st St. Station
Buildings	$ 2,575.91	$ 1,279.42
Pumping equipment	3,493.75	3,715.53
Suction well	3,892.92	6,389.23
Collecting system	5,688.29	3,358.84
Total	$15,650.87	$14,743.02

All services are metered except some private fire protection supplies. These, however, are being metered, there being at present 2 6-in. and 1 8-in. detector meters in service.

A comparison of the amount of water metered with the amount of water pumped is as follows:

	Passed through meters, Gallons	Pumped Gallons	Percentage
Second half, 1910	78,781,025	178,378,016	43.1
First half, 1911	59,034,810	131,985,826	44.8
Second half, 1911	64,876,363	143,214,929	45.3
First half, 1912	74,506,500	156,305,786	47.7
Second half, 1912	93,471,645	157,579,875	59.3
First half, 1913	86,628,792	133,885,666	64.8
Second half, 1913	131,197,050	213,521,441	61.5

The rate charged is 6 cents per hundred cubic feet. Where more than 2,000,000 gal. is used, all in excess of that amount is sold at 3 cents per hundred cubic feet.

The minimum semi-annual charge for the various sized services is as follows:

Form No. L. W. 46-200-9-1-12

REGULAR PAY ROLL
BOARD OF PUBLIC WORKS

PERIOD_____

NAME	SERVICES	1 16	2 17	3 18	4 19	5 20	6 21	7 22	8 23	9 24	10 25	11 26	12 27	13 28	14 29	15 30	31	RATE $	RATE c	RATE Per	AMOUNT Dms	LIGHT Oper.	LIGHT Closed.	LIGHT Appr. Mo.	LIGHT Amt.	WATER Oper.	WATER Const.	WATER Appr. Mo.	WATER Amt.	MAIN SEWER Amt.	MAIN SEWER Appr. Mo.	FIRE ALARM	REMARKS
	Superintendent																																
	Clerk																																
	Stenographer																																
	Collector																																
	Chief Engineer																																
	Engineer																																
	Engineer																																
	Engineer																																
	Fireman																																
	Fireman																																
	Fireman																																
	Coal Passers																																
	19th St. Sta. Att'nd't																																
	19th St. Sta. Att'nd't																																
	21st St. Sta. Att'nd't																																
	21st St. Sta. Att'nd't																																
	Electrician																																
	Line Foreman																																
	Lineman																																
	Lineman																																
	Electric Heterman																																
	Lamp Trimmer																																
	Stock Keeper																																
	Trouble Man																																
	Water Inspector																																
	Water Meterman																																

LIGHT										WATER										MAIN SEWER				FIRE ALARM			REMARKS
	Oper.		Oper.		Oper.		Oper.	Const.			Oper.		Oper.		Oper.	Const.					Oper.		Const.		Oper.	Const.		

Form No. L. W. 46-200-9-1-12

SPECIAL PAY ROLL
BOARD OF PUBLIC WORKS

PERIOD_____

NAME	SERVICES	Job No.																				No. of Hours	RATE	AMOUNT	WATER Oper.	WATER Const.	WATER Total			RECAPITULATION Job No.	RECAPITULATION Oper.	RECAPITULATION Const.	RECAPITULATION Total	RECAPITULATION Fund

FIG. 7. FORMS SHOWING REGULAR AND SPECIAL PAY ROLLS

All meters are read quarterly except those in factories, churches, liveries, schools, laundries and large private services, which are read monthly. A post card showing the monthly consumption is sent to all large users. Bills are rendered to all consumers semi-annually.

5/8-in. meter	$ 2.50	2 -in. meter	15.63
3/4-in. meter	3.75	3 -in. meter	31.25
1 -in. meter	6.25	4 -in. meter	46.88
1½-in. meter	9.37	6 -in. meter	62.50

The city pays the plant for all the service it receives except for fire hydrant service. In computing the annual profit and loss statement, however, credit is taken for hydrants at $35 per hydrant per year.

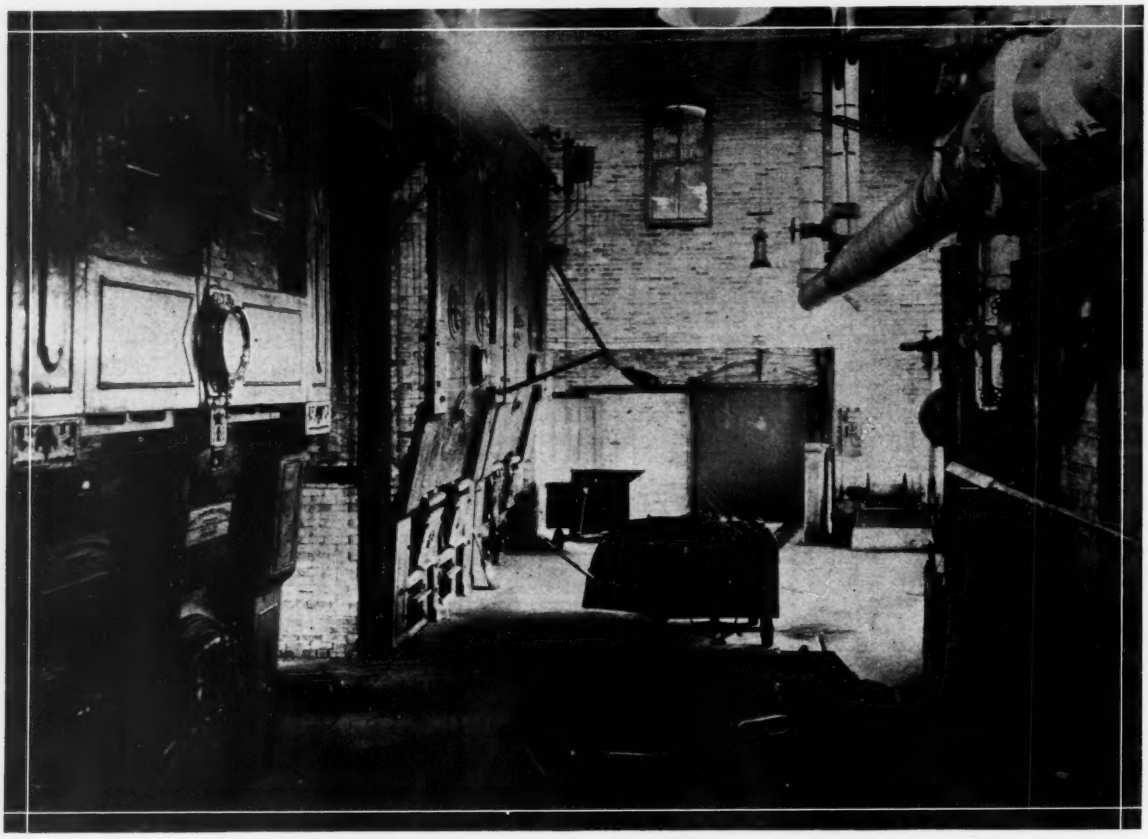


FIG. 8. VIEW IN BOILER ROOM OF 5TH STREET STATION

The last annual report shows the gross operating revenues to be as follows:

Commercial supply earnings	$17,196.20
Hydrant service	9,800.57
Street sprinkling service	1,050.00
Total	$28,046.77

The summary of operating expenses is as follows:

		Per 1000 Gal. Pumped	
Pumpage	$9,730.37	$0.0334	
Distribution	1,400.48	.0048	
Commercial	352.30	.0012	
General	1,296.32	.0045	
Undistributed	582.35	.0020	
Total operating expenses	$13,361.82		$0.0459
Taxes (estimated)	$1,706.68	$0.0059	
Interest	3,017.50	.0103	
Depreciation	6,154.38	.0212	
Total taxes, interest and depreciation	10,878.56		.0374
Total of all expenses and charges	$24,240.38		$0.0833

Facts and Factors.

1. Population 11,030
2. No. of consumers per 100 of population 19.6
3. Station capacity in million gallons per 24 hr 8.5
4. Station capacity per employe—Million gal. per 24 hr 0.85
5. Station capacity per capita—Gallons per 24 hr 776
6. Average amount of water pumped per day—Gallons 794,200
7. Average amount of water pumped per day per service gallons 364
8. Average amount of water pumped per day per capita gallons 72

SUMMARY OF THE COSTS FOR PRODUCING ELECTRICITY

Year		1909-10	1910-11	1911-12	1912-13
Item I, K. W. H.'s delivered on switchboard meters		1,680,879	1,946,814	2,085,444	2,353 747
Item II, K. W. H.'s delivered on customers' meters		1,427,780	1,608,318	1,740,706	1,999 916
Operating Costs Station	Fuel	$12,765 55	$15,991 56	$15,053 51	$16,031 75
	Labor	4,151 20	3,536 83	3,931 78	4,364 46
	Repairs	982 25	1,021 54	417,19	834 78
	Station Supplies and Expenses	214 92	209 91	331,36	491 13
	Insurance	764 64	425 02	394 27	631 54
	Total	$18,868 57	$21 211 96	$20,128 11	$23,353 66
	Cost per K. W. H. based on item I	.0112	.0109	.0097	.0100
	Cost per K. W. H. based on item II	.0132	.0132	.0117	.0117
Operating Costs Distribution	Labor	$5,653 35	$4,662 01	$4,222 99	$4,404 04
	Lamp renewals	3,481 96	2,572 85	2,816 58	1,709 16
	Repairs	1,415 38	2,662 34	2,800 82	1,680 77
	Distribution Supplies and Expenses	803 85	728 71	1,854 75	2,541 60
	Total	$11,354 54	$10,625 91	$10,695 14	$10,335 57
	Cost per K. W. H. based on item I	.0061	.0054	.0051	.0049
	Cost per K. W. H based on item II	.0079	.0066	.0061	.0054
Taxes Interest Depreciation	Taxes	$ 1,025 29	$1,025 29	$1,376 81	$1,699 12
	Interest	3,242 50	3,017 50	2,767 50	2,477 50
	Depreciation	9,329 56	9,446 96	9,484 35	11,219 97
	Total	$13,597 35	$13,489 75	$13,628 66	$15,396 59
	Cost per K. W. H. based on item I	.0080	.0069	.0065	.0068
	Cost per K. W. H. based on item II	.0095	.0083	.0078	.0081
Total cost per K. W. H. based on item I		0261	.0232	.0213	.0215
Total cost per K. W. H. based on item II		0306	.0281	.0256	.0253
Average price received per K. W. H.		0417	.0409	.0375	.0389
Profit, per K. W. H.		.0111	.0128	.0119	.0136

9. Number of fires 29
10. Fire pressure on mains—Hours 6.3
11. Investment per 1000 gal. capacity $24.33
12. Investment per capita 18.83
13. Total operating revenue per 1000 gal. capacity 3.30
14. Total operating revenue per capita 2.54
15. Total operating revenue per $100 invested 13.49
16. Ratio of expense to total operating revenue (%) 64.40
17. Net income per $100 invested 1.16

Chasing Out the Losses

THE WIDE-AWAKE ENGINEER REDUCED EXPENSES AND INCREASED OUTPUT. BY RECEIVER

WHEN a certain concern began operations, 16 yr. ago, they installed a return-tubular boiler, capable of carrying 100 lb., and 10 by 30-in. Corliss engine. In due time the plant grew and the engine was heavily overloaded, and even after speeding up, the results were not satisfactory.

Accordingly, a 72-in. by 18-ft. return-tubular boiler was installed, suitable for 130-lb. pressure.

An examination of the engine cylinder showed the material to be 7/8 in. thick, and calculation, as in Fig. 1, showed the cylinder to be able to stand 110 lb., so the

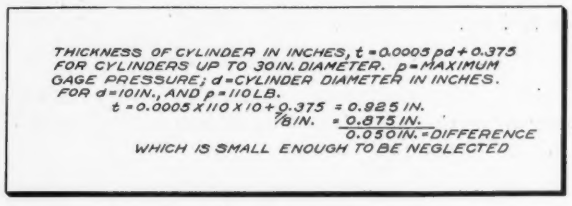

THICKNESS OF CYLINDER IN INCHES, t = 0.0005 pd + 0.375
FOR CYLINDERS UP TO 30IN. DIAMETER. p = MAXIMUM
GAGE PRESSURE; d = CYLINDER DIAMETER IN INCHES.
FOR d = 10IN., AND p = 110LB.
t = 0.0005 X 110 X 10 + 0.375 = 0.925 IN.
7/8 IN. = 0.875 IN.
0.050 IN. = DIFFERENCE
WHICH IS SMALL ENOUGH TO BE NEGLECTED

FIG. 1. CALCULATION OF DESIRED CYLINDER WALL THICKNESS

pressure was raised accordingly. In a short time the engine was no longer able to carry the load, so a 16 by 30-in., to have 110 lb. initial pressure and running at 90 r.p.m., was purchased to cut off between 1/5 and 1/4 stroke and develop 110 i.hp., giving the cards, Fig. 2.

In the new engine room a cellar was provided, also an automatic pump and receiver to return the condensation. As originally installed, this pump discharged into a tank and another pump fed the water into the boiler, the makeup valve being connected to the pump in the cellar some 80 ft. from the boiler, making unnecessary walking.

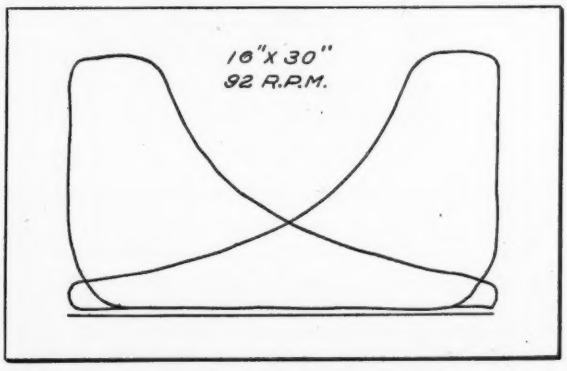


FIG. 2. DIAGRAMS FROM NEW DOUBLE-ECCENTRIC HARRIS CORLISS ENGINE WITHOUT WRISTPLATES

The second pump was stopped, the first arranged to feed direct into the boiler and the makeup water pipe had about 20 ft. more pipe connected to locate the cold water valve on the boiler front. This provided for the water level to be carried at any desired place, and the fireman to control it from the boiler room.

Engine oil was collected on sawdust, put into a fireproof can and used Monday mornings to start the fire. An oil guard, made as shown in Fig. 3, saved some 6 gal. of oil a week, which was piped to the basement and run into a filter.

An oil separator was installed in the exhaust line and the exhaust turned into the shop for heating, which reduced the coal consumption a trifle over a ton a day during the heating season.

Before the new engine was put in, the shop was gas lighted. Now, a dynamo is provided to light the shop and, due to better lighting, the output has increased about 1½ per cent.

The engineer lined up the shafting, and thereby reduced the friction load 8 hp., which represented so much energy expended and no returns resulting.

City water, used for feed, had a pitting action on the boiler, and also considerable water was used in the building. The engineer and fireman drove a well in the yard and a power pump now supplies well water necessary, saving the former water bill of $33 a month on the building alone.

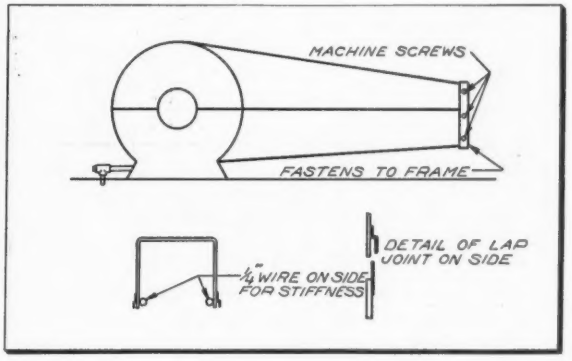


FIG. 3. CONSTRUCTION OF OIL GUARD OVER ROD AND CRANK

The belief that oil is oil, and one is as good as another, was shown up to be absurd. By different engine and cylinder oil for the engine pump, the engine friction was reduced ¾ hp., which is a considerable saving at the end of the year, especially as the cost of the second oil is no greater than the first.

It is gratifying to know that this concern appreciates its engineer, and at the beginning of the new year, he received a substantial addition to his pay envelope.

EASTERN CAPITALISTS have been investigating the lignite situation in North Dakota with a view to the establishment of large central electric power plants, from which radiating transmission lines can carry the electricity over the State.

It is asserted by practical men, who have made an investigation of the conditions, that electricity can be manufactured in the lignite belt along the Missouri River, transmission lines constructed to the eastern part of the State, and power placed at Grand Forks, Devil's Lake, Fargo and other points, at from 40 to 50 per cent of the present cost of generating power in those cities. The possibilities of generating and transmitting the electricity will be thoroughly investigated during the coming year, and huge central plants may follow.

Heating and Ventilating Large Buildings

VACUUM CLEANING. BY CHARLES L. HUBBARD

ONE of the latest pieces of equipment to be added to the mechanical plants of large buildings is the vacuum cleaner. As this seems to have been taken in charge by the heating and ventilating engineers, we will include it in the present series of articles. While vacuum cleaning was at first confined principally to dwelling houses and hotels, its field of usefulness is constantly increasing, and now includes churches, schools, halls, theaters, hospitals, office buildings, etc., and is also being utilized in shops, power plants and various manufacturing establishments.

A vacuum cleaning outfit consists of 4 essential parts: the motor, or driving mechanism; the vacuum producer; the separator, and the piping system.

The general arrangement of these with relation to each other is shown in diagram in Fig. 1, although the

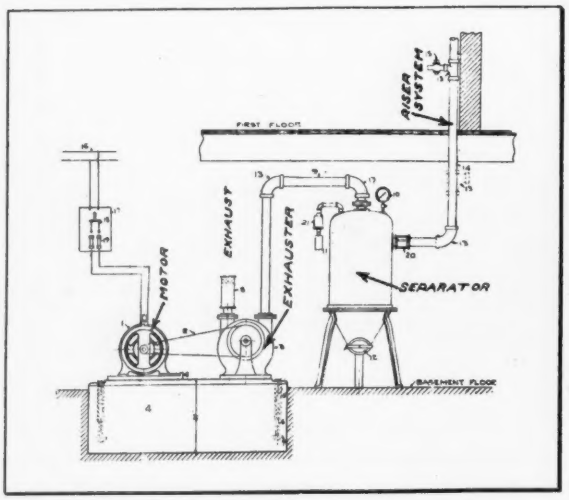


FIG. 1. GENERAL ARRANGEMENT OF VACUUM CLEANING APPARATUS

first three are often combined in a single unit. Pipe risers are carried up through the building, with outlets on each floor for hose connections with the cleaning tools or sweepers.

The number of risers will depend, of course, upon the floor dimensions of the building; it is customary in practice to limit the length of hose to about 75 ft. in order to reach all parts.

The principle of operation is simply that of maintaining a partial vacuum within a chamber with which the sweeper is connected by means of suitable piping. As the stream of dust and air enters the vacuum chamber, separation of the two is brought about either by screens or washing devices, or a combination of the two. The clean air passes on to the vacuum pump, from which it is discharged either outboard or into the room in which the mechanism is located.

DRIVING MECHANISM

ELECTRIC MOTORS are employed for this purpose more than any other driving mechanism on account of their convenience, although other means may be employed should it be more desirable. The motive power is comparatively small and the requirements more or less intermittent, both of which conditions make the electric motor particularly adapted to this class of work. The power required will vary somewhat with the type of exhauster and separator used. For average conditions, 3½ kw. per sweeper should be allowed for 6 to 8 sweeper plants, up to 4 kw. for a single sweeper plant.

VACUUM AND AIR VOLUME

THE AMOUNT of vacuum required will vary with the class of work to be done, and is commonly known as "high," "medium," and "low."

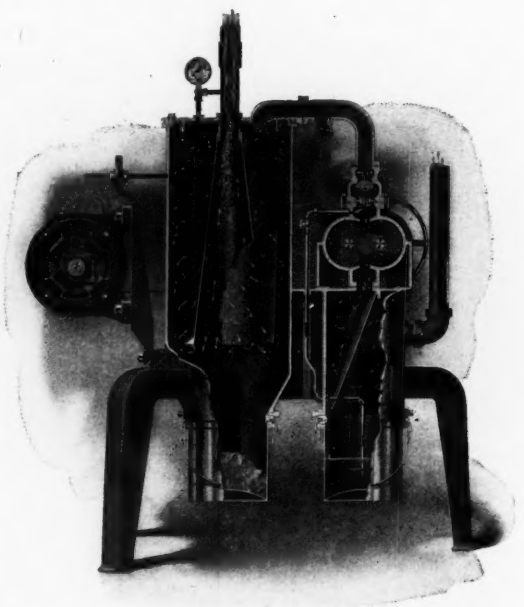


FIG. 2. SECTIONAL VIEW OF SINGLE SWEEPER MACHINE

High vacuum is required where the cleaning consists largely of heavy rugs and carpets, and for the rapid cleaning of large uncovered floor areas. It is also necessary in large buildings to overcome the friction of long runs of piping. High vacuum, as designated by the U. S. Government, calls for the exhaust of 40 cu. ft. of air per minute under a vacuum of 12 in. of mercury. A medium vacuum calls for 50 cu. ft. of air per minute under a 9-in. vacuum, and is adapted to smaller buildings with comparatively short runs of pipe and where less thorough and rapid work is required.

Low vacuum relates more to dusting than thorough cleaning, and calls for 60 cu. ft. of air per minute under a 6-in. vacuum. This is used where the pipes and risers

are very short and the requirements light and intermittent, as noted above. It is necessary, of course, that a given volume of air must pass through the sweeping tool to remove the dirt; but the reason that 40 cu. ft. is the quantity stated in connection with a 12-in. vacuum is because this is practically the amount which will pass through a 1-in. hose, 80 to 100 ft. in length, under this vacuum.

If a larger hose is used, more air will be drawn through it, but the vacuum must be maintained to get the same results. In buildings of 10 stories or more, it

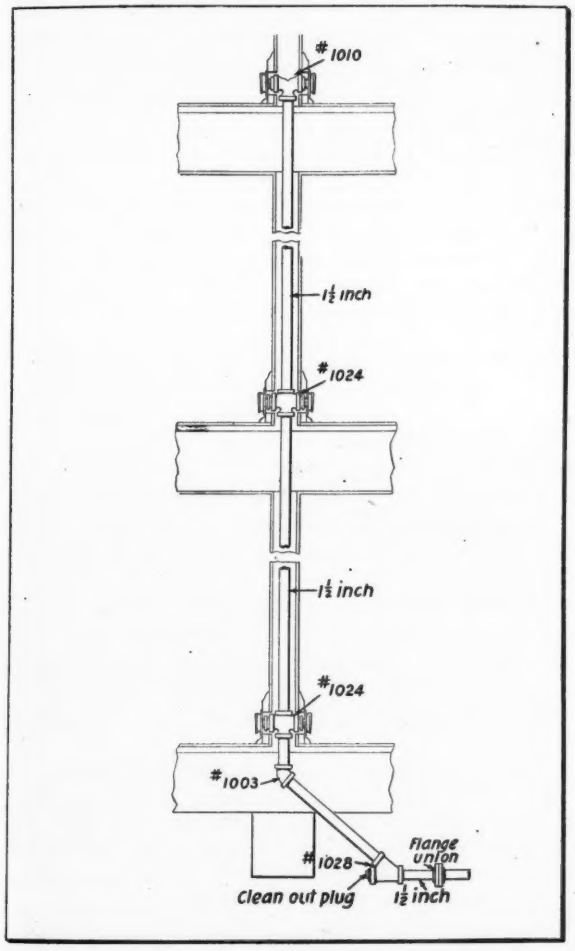


FIG. 3. RISER AND OUTLET FOR CLEANING SYSTEM

requires from 5 to 6 in. of vacuum to overcome the friction in the pipes alone before any useful work can be done by the cleaner; hence, the importance of a high vacuum is evident in cases of this kind.

EXHAUSTERS

THERE ARE 4 types of exhausters employed for this class of work, as follows: the reciprocating type, the rotary, the centrifugal and the steam jet. The first of these is limited to a piston speed of 200 ft. per min. if poppet valves are used, and to 300 ft. for mechanically operated valves.

An exhauster of this kind may be driven either by a direct-connected motor or engine, or may be belted if more convenient. In some cases a direct steam drive of the crank and flywheel type is employed.

Reciprocating exhausters must be of first-class design and construction to give satisfactory results.

The rotary exhauster is especially adapted to this class of work, being lower in first cost and operation than the above, and requiring less expenditure for repairs.

To give the best results it should be limited to a vacuum of 12 in. and a peripheral speed of about 1100 ft. per min.

Centrifugal exhausters are limited to low vacuum work and should not operate at a peripheral velocity exceeding 15,000 ft. per min. They require a special high-speed motor which is subject to extensive repairs.

The steam-jet exhauster is adapted to large buildings having no electric generating plant, but where high-pressure steam is available throughout the year.

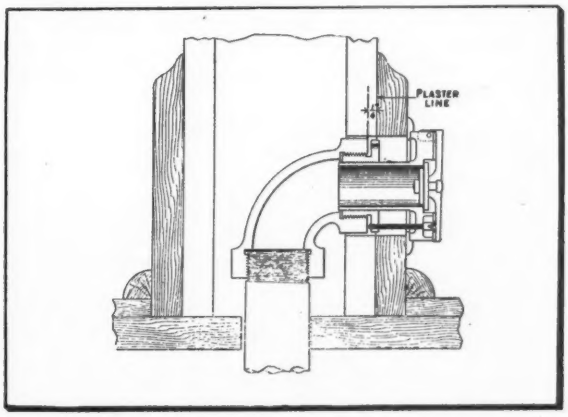


FIG. 4. DETAIL OF OUTLET FOR VACUUM CLEANER

When provided with suitable controlling devices they are fully as economical as steam or electrically driven pumps, especially when operated more or less continuously at ¼ to ½ capacity. They are low in first cost and require but few repairs.

SEPARATORS

IN CASE of the larger machines, 2 separators are usually employed for removing the dust from the air. The first of these should be a dry separator, acting upon the centrifugal principle, and capable of removing from 90 to 95 per cent of the contained dust from the air. A second separator, which may be either of the wet or dry type, should be placed between the first and the exhauster. Wet separators are provided with means for thoroughly mixing the air and water and breaking up all bubbles. They are also so constructed as to completely remove all water and dirt from the air before it enters the exhauster. When a dry separator is used for this purpose it is furnished with a cloth bag or core for removing the finer dust which remains in the air after passing the primary separator. This should be reinforced to prevent rupture and arranged so that it may be cleaned without taking the separator apart. The

cubic capacity of the separator is commonly made 3 cu. ft. for each sweeper, when of the high vacuum type, and 4½ cu. ft. for a low vacuum.

Piping

Mains leading from the machine should correspond with the outlets left by the makers, which for the standard makes are approximately as follows:

Capacity	Pipe for High Vacuum, in.	Pipe for Low Vacuum, in.
1 sweeper	2 and 2½	2½ and 3
2 sweepers	2½ and 3	3 and 4
3 sweepers	3 and 4	4 and 5
4 sweepers	4 and 5	4 and 5
6 sweepers	5 and 6	5 and 6
8 sweepers	5 and 6	6 and 8

In determining the sizes of the risers it is customary to assume that one-half the total number of sweepers will be in use at one time, and to allow the equivalent of one 1-in. pipe for each high vacuum sweeper and one 1½-in. pipe for each low pressure vacuum sweeper.

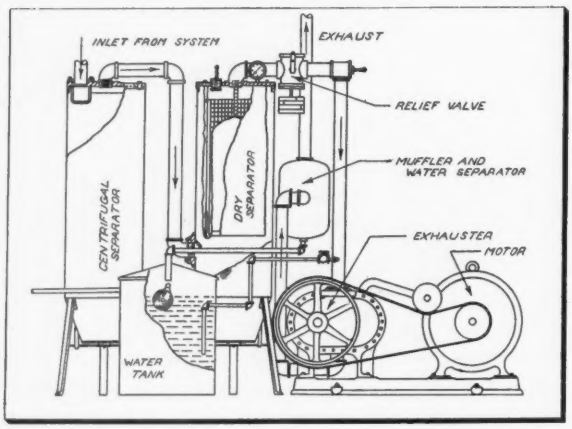


FIG. 5. SECTIONAL VIEW OF ATWOOD VACUUM CLEANING MACHINE

In proportioning the various branches, the U. S. Government makes use of the following factors, which are explained below:

Pipe Size, inches	1	1½	2	2½	3	4	5	6
Factor	10	30	60	110	175	380	650	1050

For example, the factor for a 1-in. pipe is 10, and that for a 2-in. pipe is 60; hence, one 2-in. pipe is equivalent to 60 ÷ 10 = 6 1-in. pipes. In like manner, one 5-in. pipe is equivalent to 650 ÷ 110 = 6 2½-in. pipes, and so on for any combination desired.

Standard weight wrought iron or steel pipe is used for this class of work and the ends of all pipes should be reamed. All fittings should be of the long bend sanitary type. In general, in estimating the size of plant to be installed it is customary to allow one sweeper capacity for each 50,000 sq. ft. of floor space.

When possible, the machine should be located near the center of the building, with branch mains extending in each direction, as this equalizes the distances to the best advantage.

Having taken up the subject in a general way, we will now describe briefly 2 or 3 standard makes of vacuum cleaners, in order to show the practical application of the principles noted above.

The Arco vacuum cleaner, made by the American Radiator Co., is shown in section in Fig. 2 and is a good illustration of a single sweeper machine. The 3 parts are mounted on a single base, making the outfit very compact. It is driven by a belted electric motor, provision being made for tightening the belt as it becomes slack through use.

The exhauster is of the rotary type, with 2 impellers, water sealed.

Separation is accomplished in a single chamber, which combines both a centrifugal separator and a screen.

The action of the machine is clearly indicated in the cut by means of arrows, and is as follows: The dust-laden air enters at the top of the separator through the cleaner-main, and, as it is discharged into the funnel, the heavier dirt falls into the dust bucket at the bottom. The currents of air after passing the lower edge of the funnel reverse their direction, moving upward through the double screen, as shown by the arrows, thus removing all of the finer dust which may still remain. The air now passes to the exhauster as indicated, and is discharged outboard through a pipe leading from the muffler chamber below. The connection between the separator and pump is provided with an adjustable relief valve, which regulates the strength of the suction according to the work being done.

The bucket, at the base of the muffler, contains water which is sprayed into the pump inlet, thus sealing the spaces around the impellers and increasing the efficiency of the machine.

Figure 3 shows the method of carrying up a riser and locating the outlets for the machine shown in Fig. 2, and Fig. 4, a detail of one of the outlets, illustrating the method of closing it off by means of a hinged cover which is held in place by the suction when the outlet is not in use.

The Atwood machine, shown in section in Fig. 5, operates on a similar principle and will be easily understood by reference to the notes on the drawing. This machine employs 2 separators, a centrifugal and a dry separator, as indicated. It is also made with the secondary separator of the wet type.

Single sweeper plants are made in 3 sizes, as follows:

Light Duty..... ¾ hp.
Standard .....1½ hp.
Commercial .....3 hp.

The first of these is especially for residence work, the second for small hotels, stores, office buildings, etc., and the third for heavy work in the largest buildings. Multiple sweeper machines are made in all sizes up to 10 sweepers, requiring 25 hp. Plants of large capacity are usually made up of smaller units; for example, 2 3-sweeper units connected in tandem to make a 6-sweeper system, etc. The tandem arrangement permits the use of both units together, thus effecting an economy in operation when circumstances require only a portion of the full capacity.

Power Plant Records*

KEEPING ENGINE ROOM ACCOUNTS; FORM FOR RECORD. BY GEO. H. WALLACE

PASSING on to the engine room, there is an endless variety of records that might be kept, and there are no 2 plants where these can be duplicated. Each individual case must be studied separately and records compiled to suit.

With a belted engine, driving the line shaft direct, there is no solution but indicating, and it is a good idea to apply the indicator every hour or even every half hour, during a day once a month, even weekly, if desired, and from these an average can be struck to check up against the evaporation of the boilers.

This is not such a strenuous job as it might seem at first, for if a constant be worked out for 1 lb. m.e.p., and the cards traced by a planimeter, one can soon become accustomed to it and get good results. The writer has taken cards from a cross-compound high-speed Corliss engine every 15 min. for 13 hr. without any great effort, and at the close of the run, had a horsepower chart for the day that was undisputed evidence.

The modern direct connected electrical unit whether of the turbine or engine driven type, simplifies the recording of the engine output since it is only among the smaller sizes that there are no ammeters, while indicating or recording meters are becoming quite common. Still, the engineer should know what the friction load is by indicating occasionally, if the units be of the reciprocating type.

As has been said, there is such a great variety of conditions to be encountered that no system of power plant records can become even common. But frequently, if one becomes acquainted with a system in use at one plant, he can by certain changes of a minor nature, contrive one to suit his particular conditions.

Let us take, for example, a power plant in a modern factory where the service is somewhat intermittent and devise a record sheet for it. The plant in question has 2 hand-fired water-tube boilers, each of 350 rated horsepower, 2 feed pumps (duplicates), with governor, and feed-water regulators, and an open heater.

The coal is delivered by wagon from local dealer and weighed in transit at a city scales. As it is dumped directly onto the firing floor ready to fire, no means can conveniently be devised for weighing by shifts.

Sometimes both boilers are in use until 9 or 10 p. m., and again only one, while it sometimes happens that one will suffice during the day also.

In the engine room are 2 Corliss engines, No. 1, being 525 hp. cross-compound, direct connected to an alternator, and the other, No. 2, being a 145-hp. simple, also direct connected to an alternator.

Each engine has attached conveniently, a Veeder 5 dial counter. There is also a small air compressor of 300 cu. ft. capacity, which is required to operate all the way from 10 to 24 hr. a day, depending on certain conditions existing in the process of manufacture.

On the switchboard is an indicating wattmeter which registers the total output of both generators.

Oil, waste, and other supplies are drawn from the stockroom as required, the oil in 5 gal. quantities, and the waste and rags in 5 lb. lots. As the engine is equipped with an oiling system, engine oil is drawn only as required to keep enough in the pressure tank, provisions being made to fill hand oilers from a bib cock on the oiling system.

Having a brief description of the conditions, let us proceed to device a system of recording the most important events that are likely to be found necessary. (See record sheet.)

While this record leaves many things to be desired, yet it is a start that can be improved upon according to the needs of the plant. True, there is no means of registering the amount of water evaporated daily, or during each shift, nor of the amount of coal actually consumed during each shift.

Consequently, as the weight of the coal consumed daily is not known, the percentage of ash cannot be determined, as only the total weight of the ash for each shift is recorded

The pumps can readily be fitted with Veeder counters, and then calibrated as has been described, when the quantity of water evaporated during any given time can be easily determined, and at the end of any given period, say, of a month, when the quantity of coal on hand can be estimated fairly close, the daily (24 hr.) consumption can be closely computed.

Several of the items recorded, such as the temperature of the feed water and the steam pressure, are the average result of readings taken at intervals during each shift.

Such a record sheet as is here proposed has the advantage that it is a monthly sheet, so that the performance for the entire month can be seen at a glance and those items that can be totaled, such as the total weight of coal delivered, hours of boiler service, etc., show precisely what has been done along the several different lines.

RECORD SHEET DEVISED FOR A FACTORY PLANT

*Continued from page 291, Mar. 1 issue.

While this sheet does not show the exact amount of cylinder oil used on each engine each day, but only the quantity drawn from the supply house, yet it records the hours of operation of each engine and the revolutions made for any given time, and the time of filling each oil pump can be kept track of separately if necessary.

The object of recording the revolutions of the engines is so that one can determine the cylinder wall area that a given quantity of oil will lubricate. A pint of oil will last 15 hr., and a drop is fed every 12 revolutions. The cylinder is 15 by 36 in., and the piston is 6 in. thick, thus making the area swept over by the piston during one revolution, 14 sq. ft., nearly.

Now, if one drop is fed every 12 revolutions, it means that one drop of cylinder oil has lubricated 168 sq. ft. of cylinder wall at a velocity of 900 ft. per min., and at a temperature of 360 deg.

While such a record as the above leaves many things to be desired, it presents in a clear and concise manner the most necessary items that need to be recorded about the plant. Of course, the installation of a reliable hot-water meter, and some means of weighing the coal and ashes, while it adds little to the work of keeping such a record, places in black and white for daily comparison the power house performance.

The column marked "Live steam heat," refers to the time during the night when live steam was used for heating the works. This will be compiled from the watchman's nightly report.

Then there is another simple method of keeping tab on many of the little things that come up in the plant and that one ought to keep in mind in some form, and that is a log book.

Take any kind of a blank book such as can be had for a few cents at any stationer's, or which can usually be found among the supplies of many factory offices. A book of 100 to 150 pages serves the purpose very well.

In this book enter every piece of machinery or equipment that comes under the jurisdiction of the engineering department, giving several pages to each, according to the requirements.

At the top of the first page devoted to any machine, describe it briefly, as to size, capacity, and other peculiarities, not forgetting to mention the maker.

Then as it becomes necessary to make repairs or adjustments to any machine, enter it in the log book under such machine. In this way you have a complete history, so to speak, of everything that comes under your control.

Take the engines, for example. After giving full data as to size, speed, etc., give sizes of valve stems and piston rods, and the diameter and depth of stuffing boxes. Then under dates, as they occur, enter when packed and with what kind of packing, length of time it was in and what kind of satisfaction given. The same way when examining the valves or bearings or the interior of the cylinder. Enter it all on the log for future reference.

With the boilers, make note of when washed, what condition they were in, what compound was being used, if any, and any other matters such as when combustion chamber was cleaned, condition of the brickwork, grates, arches, baffles, etc. If necessary to calk rivets or tubes record it specifically, as a recurrence of these troubles in the future might reveal some defect in manufacture and it is well to have a complete record of them.

The same way with the pumps, paying special attention to packing, and so on down through the list of feed-water regulators, pump governors, vacuum pumps, heater, main steam header traps, etc., so that you will have listed every piece of apparatus about the plant.

Make an index of the various subjects on the front page, and indicate on which page any piece of apparatus can be found. Then if you do even so little as to add a ring of packing to a pump, enter it in the book. It requires but little time to do this and later on you will find great satisfaction in referring to the book for needed information that otherwise would have escaped you.

It is true that all this requires time, yet in a way, it saves time, for nothing is left to mere guess work and it is not necessary to go over the many things again and again to see how they have been working out. A well kept record sheet and log book are 2 of the best recommendations that an engineer can have.

International Exposition for Marine Motors

By Vice Consul Wm. McKone Milner, Calais, France

An Exposition for Marine Motors for Vessels of All Tonnages is to be held in Boulogne-sur-Mer, France, in June, July, August, and September of this year. This exposition is to open on June 15 and should be of great interest to all American builders of marine motors who are giving any attention to business in Europe.

Boulogne-sur-Mer is the leading fishing port of France and is one of the most important centers for the fishing industry in the world. In 1912 there were fitted out at Boulogne-sur-Mer for fishing 528 vessels, aggregating over 65,000 tons, manned by 9885 seamen, and representing an investment of over $9,000,000; 36,000 tons of coal were used for bunkers, while 29,000 tons of ice and 10,000 tons of salt were utilized. The total catch of the fleet sold for nearly $6,000,000.

Gasoline is so expensive (50 cents a gallon) that its use on fishing boats can not be considered. Even benzol is too expensive. Heavy oil engines will, therefore, have the best opportunity.

It is not likely that anything will be able to take the place of steam for trawling, but for herring and mackerel fishing, power is only needed to get to and from fishing fields in head winds and calm weather, while fishing vessels need no power except for heaving in the gill nets.

Economy in operation will be all important and have the greatest effect on the decisions of Boulogne ship owners. Competitors will be Swedish, Danish, Dutch, German, Belgian, British, and French constructors of marine motors.

The opinion here is that Americans in general build the best marine motors.

There will likewise be held at Boulogne-sur-Mer, in June, July, August, and September, as a part of the Marine Motor Exposition, an exposition for cold-storage apparatus applied to the fishing industry and concerning the transportation and preservation of fish on land and on shipboard. The interest here in cold storage is at present very great, and this exposition will be very important and should be of considerable interest to American manufacturers.—Daily Consular and Trade Reports.

Location of Valves

POINTING OUT THE DANGEROUS FEATURES OF INDIANA STATE LAW ON BOILER PIPING. BY J. C. HAWKINS

FOR the benefit of those that do not fully understand the reason why placing the valves in the steam line, as prescribed by the Indiana state law, is a dangerous practice, I wish to state some of the reasons why I hold this opinion.

Section 17 of this law regarding stop valves reads as follows:

"Sec. 17. On all steam lines there must be a cutoff valve placed in the steam pipe not farther than 18 in. from the boiler shell.

"On all boilers installed on and after July 1, 1913, where 2 or more boilers are connected to the same steam line or main, the branch pipe to each boiler shall be provided with 2 stop valves, one to be placed near the steam main and the other not farther than 18 in. from the boiler.

"In water-tube and all other boilers carrying 100 lb. steam pressure or over, an automatic shutoff valve must be placed between the boiler and stop valve."

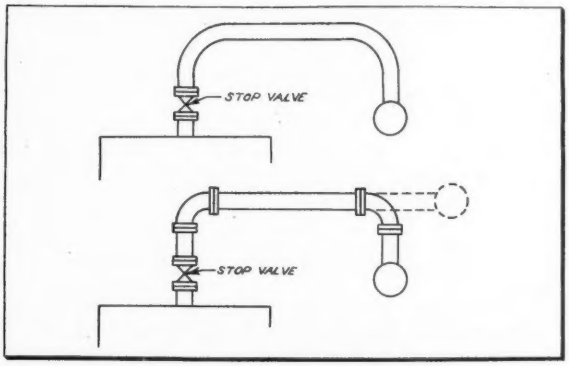


FIG. 1. VALVE LOCATION THAT CONFORMS TO THE INDIANA LAW

Figure 1 shows the steam connections of a boiler that conforms to the first paragraph of this section. There is no drain valve above the valve, as the law does not require it. The second paragraph of this law says, "On and after July 1, 1913, this construction is not allowed except on one-boiler plants and will not be considered further. Figure 2 shows the construction required by the second paragraph of this law with a valve 18 in. from the boiler, and a stop valve near the header. In this, as before, no drain valve is required; however, if the boiler is to carry 100 lb. pressure or over, as stated in the last part of this section, there must be an automatic stop valve between the stop valve and boiler, which would either require 2 stop valves and an automatic valve, or the automatic valve would have to be used in place of one stop valve, which would be practicable. Figure 3 shows the same kind of connections where the head room is limited, and the branch is nearly horizontal, as prescribed by this law.

Referring back to Fig. 2, if a drain pipe is connected above the valve, and properly used every time the boiler is cut in, there will be little chance of damage from water hammer. But that little IF is just where the trouble lies, and state boiler laws are passed to prevent, as far as possible, those in charge of power plant machinery from doing what they ought not to do. If the law is so written that it does not prevent a construction or operation that is dangerous, what good is the

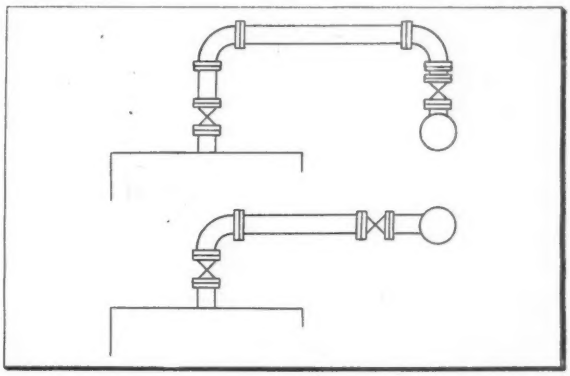


FIG. 2. LAWFUL VALVE LOCATION FOR MORE THAN ONE BOILER

law? The law question does not require a water pocket in the steam line to be drained, and a contractor would be within the law if he did not put a drain pipe in. Somebody said that an engineer ought to be ashamed of himself or have his license revoked if he did not do all the cutting-in himself. That might well apply to the little 2-man plant, but not in a large plant where the engineer cannot do all the work alone. In one plant

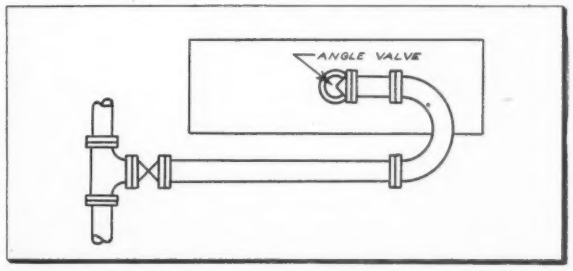


FIG. 3. PLAN VIEW OF BOILER LEAD WHERE HEAD ROOM IS LIMITED

of 1500 hp. of which I had charge, the 6 boilers working at 150 lb. pressure were connected to the steam header as shown in Fig. 1, with a drain pipe above the valve. In the rush of starting up on Monday morning, sometimes I did not have time to watch the boilers, and the water tender did the firing up and cutting-in at the proper time. He usually opened the drain valve before cracking the stop valve but on 1 or 2 occasions forgot

it, and from the noise of the water hammer telegraphed along the pipe line to the building where I was warming up an engine, I thought a boiler had exploded.

The instance in which the valve next the boiler was ruptured, as stated in my former letter, was purely a case of water hammer. The 6-in. branch is as shown in Fig. 4 with an angle valve at A and a gate valve at B. As the head room is low, the steam pipe had to be low to pass under a 24-in. girder, which brought the valve B 4.5 in. lower than valve A. No drain valve was provided, although the specifications called for it. The fireman usually opens the angle valve when first starting the fire, but as the load was heavy and one of the stokers was broken down, he told the helper to do it, which would have been all right as he had opened these valves before, but he opened the wrong valve. The bursted angle valve was built for 250 lb. pressure and was a sound casting. The boiler pressure is 100 lb. We now have an automatic stop angle valve at A and a drain valve at C, but the design is just as dangerous as before, if the man forgets the drain valve.

Figure 5 shows the proper location of valves in a boiler branch in which A is the automatic valve and B the stop valve. This arrangement requires no drain valve, as no water pocket can be formed, therefore the danger of water hammer is eliminated, and the cost of construction would be the same; but this cannot conform to the Indiana law because, if the valve is within 18 in. of the boiler shell, it cannot be near the header. The reason that the valves should be bolted together is, that the stop valve may be opened while the boiler is being

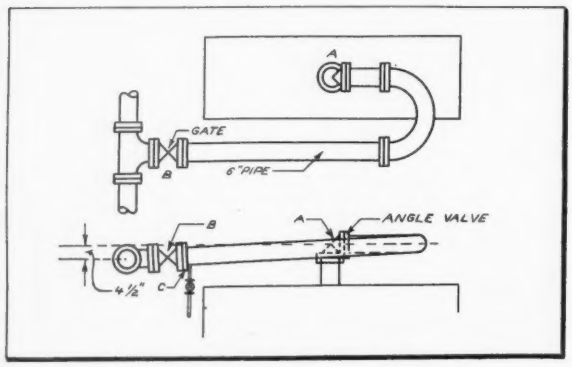


FIG. 4. PIPING THAT GAVE TROUBLE

fired up, with no chance for serious water hammer to occur as would be liable in the other construction, if the drain valve were not used, and the automatic valve, if of proper design, will open when the pressure is equal on both sides of it.

When connected in this manner, it is not necessary for the boiler man to go on top of the boilers to cut them in.

In regard to lifting the safety valve, we have an idea that works satisfactorily. Our boilers have 2 safety valves on each, one lever, and one pop valve; the latter is set at 2 lb. lower than the lever valve. We have a light chain like that used on the gage cocks connected to the levers, and passing over pulleys to an inconspicuous place where it can be reached from the floor by the fireman who lifts the valve every day.

As stated in my former letter, the pipe arrangement as specified by the laws under discussion might be operated for years without trouble, and then some engineer or other employe might lose his life from improperly operating valves whereas, if the law is amended to make it necessary to have the valves so located that there will be no possible chance for a water pocket to form, it will be just as safe as far as construction is concerned, and eliminate the possibility of water hammer at this point. In boiler plants already installed, some makeshift such as traps and drains may be permissible, which in a large plant would be much cheaper than repiping the boilers;

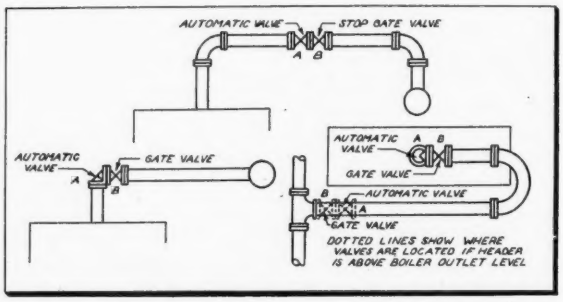


FIG. 5. PROPER LOCATION OF VALVES IN BOILER LEADS

but in all new plants the piping should be installed in such a manner that it will give the least possible chance of accident, and that cannot be done, if the present law is complied with, and as it prohibits a construction that is safe and sane it is worse than no law at all.

Mathematical Wonder

IN Machinery, Uncle Josh gives a trick with numbers that is an impossible mystery to the uninitiated.

"Now, gentlemen, give me 3 numbers and I will put in 2 more and after you give me the first one, I will tell you the sum of the 5 before I know the other 2."

So Jones said 5,398,274, and the "professor" wrote 25,398,272 as the sum. Other numbers were then given and written as follows:

Jones first number	5,398,274
Jones second number	365,892
Professor third number	9,634,107
Jones fourth number	6,987,328
Professor fifth number	3,012,671
	25,398,272

"Add 'em up and see for yourselves," said the professor.

Now the solution. Compare the sum with the first number; it has 2 at the left and 2 subtracted from the right-hand digit. Add the second and third numbers; all digits come out 9; likewise for the fourth and fifth. The mystery is solved. Seven numbers might be used by the "professor" giving 3 to Jones' 4. To get the sum, put 3 in front of the first number given and subtract 3 from the right-hand digit. Or for 9 horizontal rows use 4 to subtract and prefix.

Electrical Machinery and Appliances

For Generating, Transmitting and Using Current

Practical Electrical Engineering*

CALCULATION OF ARMATURE AMPERE-TURNS

WE have already seen that when the brushes are set at the neutral point geometrically, demagnetization is not caused directly by the armature ampere-turns, distortion only being the result. With a forward lead of the brushes, part of the armature ampere-turns oppose those of the field or tend to demagnetize the field poles. If we look at Fig. 4, it is evident that current in all conductors is flowing from one side of the armature to the other, producing a cross magnetism which will combine with that from the field coils to distort the direction of the field as indicated in Fig. 6, increasing field strength under the leading pole tips and decreasing it under the trailing tips.

When the brushes are shifted to B, Fig. 5, the current in conductors in front of the poles is flowing from side to side as before, producing cross magnetization, but those conductors between B and B^1 will have current flowing from top to bottom, producing a magnetization opposed to that of the poles, thus weakening the field. Considering the armature winding magnetic effect as a whole, the effect would be as indicated in Fig. 7, a distortion and also a weakening of the field.

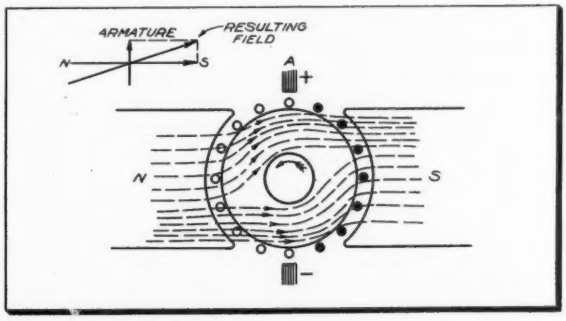


FIG. 6. EFFECT OF CROSS MAGNETIZATION ON FIELD SHAPE AND STRENGTH

The cross magnetization, because of the twisting of the field, results in a greater lead of brushes being necessary to get far enough under the weakened pole tip to secure sparkless commutation. The back magnetization may weaken the field sufficiently to affect the voltage, hence must be computed, and provision made for overcoming it, if necessary. The means usually chosen to neutralize armature reaction are series windings on the poles, slotting the poles to reduce field distortion, hence the brush lead needed, thinning down and shaping pole tips to get saturation for the same purpose, interpoles with windings opposing armature coils m.m.f. and series windings placed in the main pole faces for a like purpose.

To determine the back ampere-turns: A = the number of commutator segments per pole; B = the number of segments forward lead of brushes; I = rated full load current of generator; D = number of conducting paths through the armature from positive to negative brushes; and J = the number of armature turns per coil. Expressed in ampere-turns per pole, the total armature effect at rated full load will be found by multiplying the coils per pole (which will equal A) by the turns per coil and by the total current, and dividing by the number of paths or circuits through the armature; or, a.t. per pole = $A\,J\,I \div D$.

Study of Fig. 5 shows that when the brushes are shifted forward by B segments, 2 B coils, the number between lines B and B^1 are changed into back ampere turns; hence, the back a.t. will be the total a.t. per pole times $(2\,B \div A)$ and we have; back a.t. per pole = $A\,J\,I \div D \times (2B \div A) = 2\,J\,I\,B \div D$.

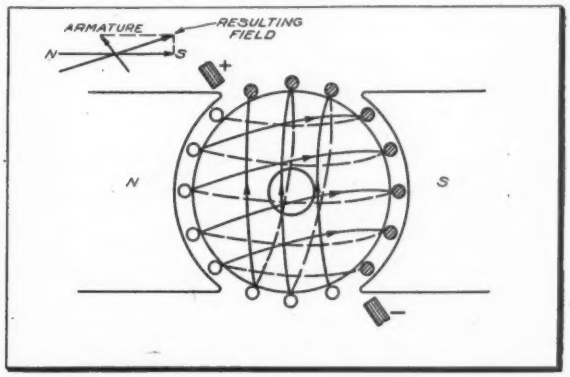


FIG. 7. BACK AND CROSS AMPERE-TURN EFFECT ON FIELD

In Fig. 5, assuming 20 amperes full load current, and 1 turn per coil, we have A = 8, B = 1, I = 20, D = 2, J = 1; then the total a.t. $= 8 \times 1 \times 20 \div 2 = 80$, and back a.t. $= 2 \times 1 \times 20 \times 1 \div 2 = 20$.

AN EXAMPLE

ASSUME THAT the winding is to be figured for the armature whose field was calculated in the issue of Jan. 15, page 155, we tabulate the following data needed.

*Continued from page 297, Mar. 1 issue.

Rated capacity, 100 kw.
Voltage, 250 v.
Flux per pole, 4,275,000 lines.
No. poles, 4.
Armature—outside diam., 20 in.
Armature—inside diam., 11 in.
No. circuits, 4.
Speed, 1000 r.p.m. = 16.7 r.p.s.
Armature length over all, 8 in.
Armature net length of iron, 6 in.
No. slots, 80; depth, 1.4 in.; width, 0.35 in.
Density in armature, 114,000 lines per sq. in.

First we must decide how many conductors will be needed, and from formula (1) of Fig. 1 we have;

$$N = \frac{250 \times 100{,}000{,}000}{16.7 \times 4 \times 4{,}275{,}000} = 87.7 \text{ conductors per}$$

circuit. As there are 80 slots, or 20 per circuit, it will be necessary to have the conductors per circuit divisible by 20, and this must also give an even number of conductors per slot, so that when 2 conductors are wound into a coil, there will be an even number of coils. This means either $20 \times 4 = 80$, or $20 \times 6 = 120$ conductors per circuit. To use 80 will mean increasing speed or magnetic density, neither of which is desirable, so 120 is chosen.

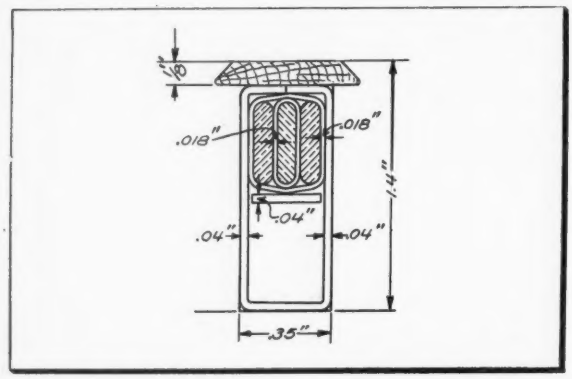


FIG. 8. ARRANGEMENT OF SLOT AND COIL INSULATION

It now becomes necessary to determine what size conductor can be gotten into the slot. We must provide for proper slot and coil insulation as indicated in Fig. 8.

Slot insulation will consist of pressboard and muslin about 0.04 in. thick, and coil taping, lapped half, will be 0.018 in. thick. The wedge at the top of the slot is ⅛ in. thick, and 0.02 in. should be allowed per coil for clearance. In depth this takes up as follows: Wedge, 0.125 in.; 3 layers slot insulation, 0.12 in.; 8 layers coil insulation 0.104 in.; 2 clearances, 0.04; total, 0.389 in. Subtracting from 1.4 in., the slot depth, gives 1.011 in., or practically 0.5 in. for the depth of each strip.

For the thickness we have: Two layers slot insulation, 0.08 in.; 4 layers coil insulation, 0.072 in.; 1 clearance, 0.02; total, 0.172. Subtract from 0.35 in., the slot width, and there is left 0.178 in. to be divided into 3 strips, or 0.059 in. per strip. If 1/16-in. is used it will be 0.0625, which can be worked in by careful handling. This gives strip ½ by 1/16 in. with rounded edges.

The sectional area will be a 1/16-in. circle plus a rectangle 0.5 by 0.4375 in. The area of the circle is 0.0031 sq. in. and of the rectangle 0.027,35 sq. in., or 0.030,45 sq. in. total. This is 30,450 square mils, and dividing by 0.7854 gives 38,800 circular mils.

For a 100-kw. machine at 250 volts the current is $100{,}000 \div 250 = 400$ amperes, and as there are 4 armature circuits, each armature conductor carries 100 amp. so that the strip has $38{,}800 \div 100 = 388$ circular mils per ampere. This is rather low, for it is usual to allow from 500 to 600 circular mils per ampere, but it may work out if the generator is not called on to carry overloads to any extent. It will be best, however, to calculate the heating to make sure.

Armature Heating

One conductor has a length of 8 in. in the core, and a turn will consist of 2 conductors plus 2 end connections. The connection spans ¼ the armature at the middle of the slot depth, and from the Jan. 15 issue, we find that the circumference at this depth is 58.43 in.; ¼ this is 14.61 in. or say 14.625 in., to allow for rounding corners. A turn will then be $2 \times 8 + 2 \times 14.625 = 45.25$ in. long. There are 480 conductors on the armature, or 240 turns, and this will be 60 in each circuit, or a length of $60 \times 45.25 = 2715$ in. or 226 ft. Allowing for resistance of connections call this 230 ft.

From the wire tables we find that 38,800 circular mils is a little smaller than No. 4 wire whose resistance per 1000 ft. is 0.25 ohms, so we allow 0.26 ohms for the strip. Then 0.26×0.230 gives 0.0598 or about 0.06 ohms as the resistance per circuit, and for 4 circuits in parallel the resistance will be $0.06 \div 4 = 0.015$ ohms, the resistance of the armature.

Heating loss from resistance will then be I^2R or $400^2 \times 0.015 = 2400$ watts.

For hysteresis loss we have the frequency, $f = 16.7 \times 2 = 33.4$ cycles per second.

Computing the weight of the core is a tedious job if we work it exactly, considering slots, spider arms and all, but for our purpose, it will serve to consider the core as a hollow cylinder 6 in. long. The annular area of the end, times the length will then give the volume. Area for 20 in. diameter is 314 sq. in.; for 11 in. diam. is 95 sq. in.; difference is 219 sq. in. This times 6 in. gives 1314 cu. in. of metal which at 0.22 lb. per cu. in. gives a weight of 289 or say 290 lb.

From the expression for hysteresis loss we get:

Watts $= 290 \times 33.4 \times 114{,}000 \times 0.000{,}001{,}8 = 1980.$

Adding to the resistance loss gives $2400 + 1980 = 4380$ watts heating effect.

The area of a 20-in. circle is 314 sq. in. and for 2 ends gives 628 sq. in.; the circumference of a 20-in. circle is 62.8 in. and for 8 in. long gives 503 sq. in. cylindrical surface, or a total of 1131 sq. in. radiating surface. Dividing 4380 by this gives 3.875 watts per sq. in., which, while high, is permissible.

Back Ampere-turns

It is well now to check for back ampere-turns. To decide on the commutator segments, allow 5 volts per segment; $250 \div 5 = 50$ segments per pole or 200 in all as a minimum. As the turns must be an even multiple of the segments, and there are 240 turns, 240 segments must be used, 1 turn to a segment and 60 segments to a

pole. A lead of 0.1 the pole pitch will be safe, or 6 bars on the commutator, and the expression for back ampere-turns then becomes:

Back a.t. $= 2 \times 1 \times 400 \times 6 \div 4 = 1200$ a.t. per pole. This would call for $1200 \div 400 = 3$ turns per pole, but as some turns will be needed to balance cross magnetization, also some allowance for inaccuracy in figures, it would be well to use 5½ turns and adjust current as may be needed by a series shunt, the half turn being used for convenience in connecting up coils.

It is well to check the voltage computation to make sure that there is margin for armature and series field drop and brush resistance. Some stray lines will not pass across armature conductors, but will leak through air and teeth, and allowing 20 per cent for this, $4{,}275{,}000 \times 0.80 = 3{,}420{,}000$. Then E.M.F. $= 120 \times 16.7 \times 3{,}420{,}000 \times 4 \div 100{,}000{,}000 = 273$ volts, which is plenty of margin.

Dimensions here found are not put forth as ideal for a commercial machine, but to illustrate the method of making the computations. To get final, satisfactory results it is necessary to change dimensions and repeat computations until satisfactory conditions of loss, efficiency, heating, and mechanical proportions are obtained.

Public Service Charges for Electric Current

By H. W. Ashley

RATE schedules filed with the Public Utility Commissions in Ontario, Ohio and Indiana publish prices of 4 cents per kilowatt-hour for domestic current at Toronto, 7 cents at Toledo and 12 cents at Indianapolis. The Edison Co., it is reported, offered to provide current for the Equitable Life Insurance building in New York City for the equivalent of 0.5 cent per kilowatt-hour, while the small consumer is charged 10 cents for a like and simultaneous service.

The gross revenues of public service companies for current sold in the United States during 1913 was about $450,000,000. Seventy-five per cent of this amount was paid by the domestic and small consumer, the average charge for electricity for household or retail use being 10 cents per kilowatt-hour.

The knowledge of such wide variation in rates and such vast revenues collected for this semipublic service gives rise to the wide-spread agitation everywhere observable for a revision of public service electric schedules, or the construction and operation of municipal electric light and power properties.

These utility companies which sell electricity "perform a public service"; they enjoy "special privileges" such as the right to use the streets and, like railroad, water and gas companies, are circumscribed in respect to the charges they may impose. The merchant or manufacturer may sell where and to whom he pleases and at what price he may be able; the public service company must serve everyone and at the same price, under similar circumstances and conditions.

A discussion of public service electric rates which disregards these principles is misleading and futile.

The bases for railroad transportation and for water and gas charges have been made and repeatedly affirmed wherever English common law limits and defines commercial activities. A railroad company may not charge more per ton for 1 than 50 or 1000 car loads of the same commodity. Nor can a gas company legally charge a higher rate per 1000 cu. ft. of gas for illumination than for fuel or power. Nor can a common carrier legally make lower rates to a customer who may send his oil by pipe line than to another because he is without access to this means of transportation. Different rates cannot be predicated solely on competition.

"Discrimination," says Webster, "is the arbitrary imposition of unequal tariffs for the same service." "And," says the court, "any public service rate made solely by reason of quantity or use or competition is discriminatory and therefore illegal."

"The principle of equality," says the Court, "forbids any difference in charge which is not based upon a difference in service, and even when based upon a difference in service must have some reasonable relation to the amount of such differences."

This, then, is the fundamental principle which circumscribes the legal rate schedules of all public service companies. They must be based upon an essential difference in the cost of the service rendered.

The electric public service companies which manufacture and distribute current in Toledo, O., charge the householder 7 cents per kilowatt-hour, while in Indianapolis, Ind., 12 cents is exacted for the same service. And the same companies sell current to manufacturers and department stores, made and transported at the same time, for from 1 to 6 cents per kilowatt-hour.

The bold question is presented then: Does it cost 7 times more in Toledo and 12 times more in Indianapolis to provide current for the householder than for the manufacturer?

Operations incident to pumping and distributing water are similar to those employed in making and transporting electric current. A superintendent of a municipal water department recently refused to supply a railroad 1,000,000 gal. of water daily at 2.5 cents per thousand. He computed that 6000 individual taps consumed 1,000,000 gal. daily, and that the cost of reading meters, clerical work and interest and depreciation on service connections for 6000 customers was 0.3 of a cent per 1000 gal. The difference in the cost of service between one customer who consumed 1,000,000 gal. daily and 6000 customers, to whom the same amount was sold in the same time, was 5 per cent, or 0.3 of a cent less than the regular 6-cent rate.

The difference in the cost of electric service to the wholesale and retail customer is limited, like that of water, to the additional cost of reading meters, making and collecting accounts, and interest and depreciation incident to the connections necessary to provide current to small consumers. Accurate and intelligent accounting would discover the elements of expense involved in serving 1,000,000 kw. to one or to 1000 purchasers and would determine whether any compensating conditions, such as the relative load factor, render the service of small consumers more or less profitable than the department store or the office building.

When a corporation chartered to perform a public service charges a department store 2 cents per kilowatt-hour and a nearby competitor in a small store 10 cents per kilowatt-hour for a like and simultaneous service, should its officers not be required to prove that the 10-cent rate is not an "arbitrary imposition of an unequal tariff for the same service"? By such a concrete example it is made clear that discrimination is not wrong because it is illegal, but illegal because it is wrong.

Portable Substation for a Mine

THE Berwind-White Coal Mining Co., Windber, Pa., has recently added a 400-kw. Westinghouse portable substation to its equipment and is making a very interesting use of it.

This substation consists of apparatus for changing alternating current into direct current, as is generally necessary in mining work because direct current must be used for haulage in mines but cannot be transmitted economically over long distances.

The Berwind-White Co. is developing its outlying properties rapidly and needs direct current at points where permanent substations are not yet erected. In order to prevent delays in the development, the use of a portable substation was decided on.

When the work at a new development reaches the point where direct current is necessary, the portable substation is hauled out to the workings, connected to the alternating-current transmission system, and is

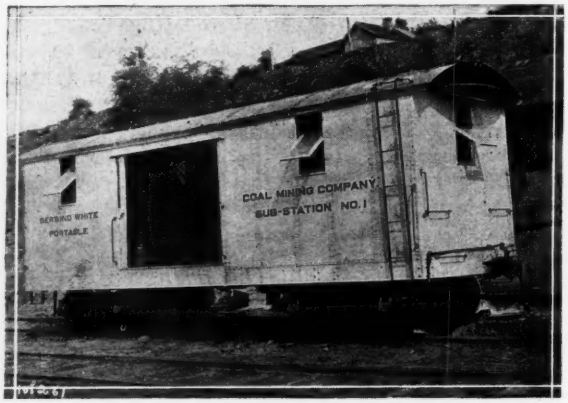


FIG. 1. SUBSTATION READY FOR THE ROAD

started to work generating direct current. When the permanent substation is built, the portable becomes unnecessary and is taken to the next development.

A further use of this substation is to provide insurance against shutdowns. If accidents occur at any of the permanent substations, the portable outfit is sent

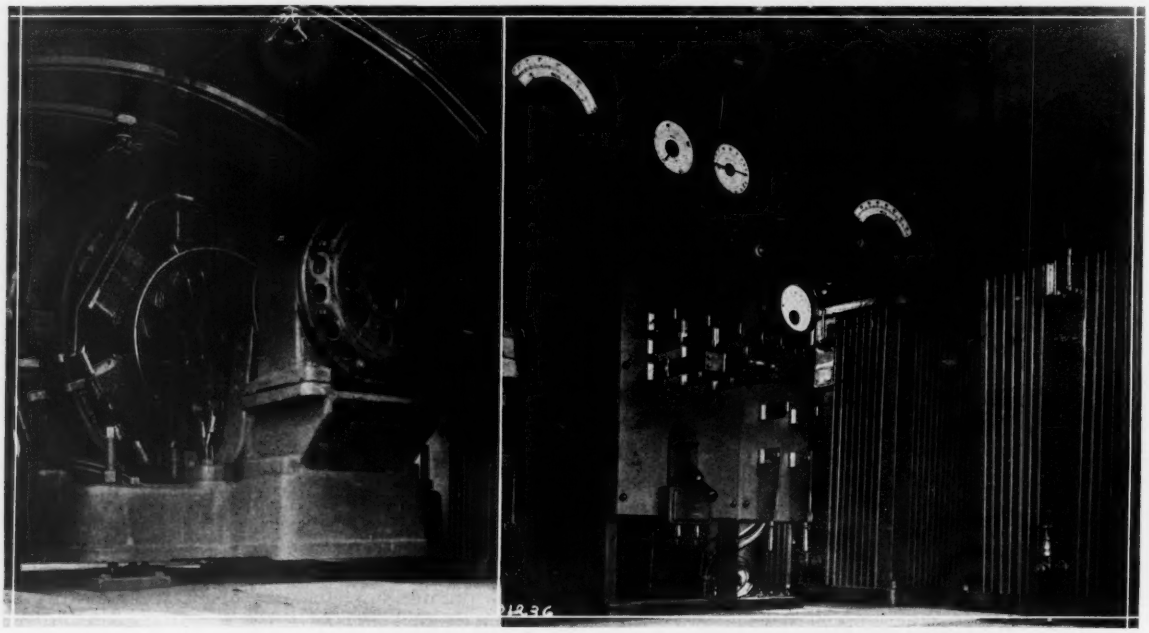


FIG. 2. INTERIOR OF SUBSTATION CAR, TRANSFORMERS, SWITCHBOARD AND ROTARY CONVERTER

This has the same equipment that a permanent installation has; namely, transformers to step down to a moderate value the high voltage of the current received from the transmission line, a switchboard, and a rotary converter, which receives alternating current and delivers direct current. This apparatus is mounted in a car resembling an ordinary freight car.

to carry the load until repairs are completed. One portable substation, therefore, is practically the equivalent of a duplicate set of apparatus at each permanent substation.

THE PENINSULAR POWER CO., will spend $80,000 to $100,000 in Iron River, Mich., this summer, remodeling and adding to its power plant.

Comparative Tests of 3 Types of Lineshaft Bearings*

SPECIAL APPARATUS DESIGNED TO DETERMINE TEMPERATURE RISE AND POWER REQUIRED FOR VARIOUS LOADS AND SPEEDS. BY CARL C. THOMAS, E. R. MAURER AND L. E. A. KELSO

THESE tests were made in order to ascertain definitely the relative and absolute amounts of power required to drive a specially constructed lineshaft carrying given loads at certain known speeds of revolution, when supported successively by 3 different types of shaft bearing, and to determine coefficients of friction for each type. The 3 types tested were ring-oiled babbit bearings, roller bearings, and ball bearings.

Twenty bearings of each type were used in these tests in order that representative results might be obtained. The bearings were loaned in 1909 by the manufacturers and the testing apparatus was designed and built in the department of steam and gas engineering, University of Wisconsin.

The apparatus consists of 25 ft. 10 in. of lineshafting in 5 equal sections, mounted in hangers S which are inverted and used as floor stands. The hangers are bolted to 2 8-in. I-beams which are leveled upon the floor. The shafts are of cold rolled steel, 2 7/16 in. in diameter. Each section is 5 ft. 2 in. long; the adjacent sections are coupled together by means of a flexible leather disk or 2 straps connecting the 2 flange couplings.

A direct-current motor is directly connected to one end of the shafting by means of a flexible coupling. The power is measured by means of calibrated instruments, namely, voltmeter and ammeter. A water rheostat is used in the field circuit to maintain a constant field, and another water rheostat is used in the armature circuit to vary the speed by varying the impressed voltage.

The load is supplied through levers upon hardened knife edges and pin points as fulcrums. Across the top of the 8-in. I-beams, and at right angles to them, are bolted short 6-in. I-beams to which the fulcrums are attached. Standard 1000-lb. scales are set upon the 6-in. I-beams.

A double system of leverage is used in order to get sufficient load upon the bearings with as short a length of leverage as possible. This double system of levers also serves to steady the apparatus and prevent excessive vibration.

The loads are applied to the shaft by 2 bearings between each pair of hangers. These bearings are identical with those in the hangers, and are supplied with knife edges which engage a V-shaped groove in the 5-in. I-beam levers. The bearings and hangers for each section are symmetrically placed with respect to the middle of the section; therefore, equal loads on the intermediate bearings, I, produce equal pressure on the end bearings, E. These latter pressures exceed those on the intermediate bearings by one-half the weight of the shaft, or by 40 lb. This difference is regarded as negligible in the paper, and load per bearing means average of the loads on intermediate and end bearings. The bearings are prevented from turning by short levers fastened to the bearings and resting upon uprights from the floor. Only one type of bearing was tested at a time, so that no complications might arise in establishing the losses for the particular bearing under test.

The 3 kinds of bearings tested were: The Hess-Bright ball bearing, manufactured by the Hess-Bright Manufacturing Co., the ring-oiled bearing manufactured by The Dodge Manufacturing Co., lined with babbit metal; and the Hyatt roller bearing, manufactured by the Hyatt Roller Bearing Co. All bearings were for the same size shaft and, in fact, the same pieces of shafting were used for all the tests, except that 2 sections bent during the test were replaced.

The babbit bearings are 9 21/32 in. long and hence their projected area is 22.36 sq. in. The following table

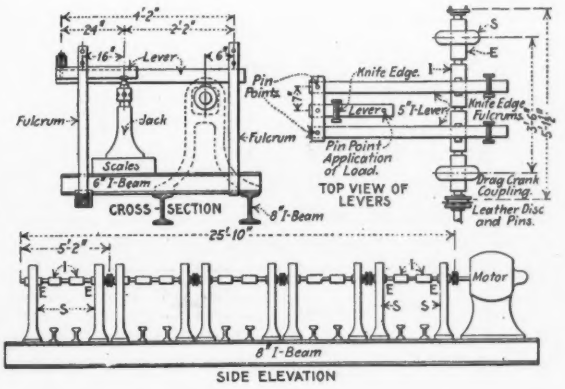


FIG. 1. DIAGRAM OF APPARATUS FOR TESTING LINESHAFT BEARINGS

is appended here for converting total loads used in the tests, and frequently mentioned later, into unit loads.

730	1230	1730	2230 lb. per bearing.
33	55	78	100 lb. per sq. in.

These bearings were oiled by the ring oiler device, 2 rings in each bearing.

Each roller bearing contains 6 right-hand and 6 left-hand rollers, 0.780 in. in diameter; 6 are 9 9/16 in., and 6 are 9 3/16 in. long. The bearings are of the type in which a cage is used for holding one-half the rollers. Each ball bearing contains a single set of balls 9/16 in. in diameter. The diameter of the inner race through ball groove is 3.4729 in.

Mercury thermometers (2 in each babbit and roller bearing, and one in each ball bearing) were used for measuring the temperature of the oil or bearing.

*Abstract of paper read before A. S. M. E.

In order to avoid the endwise thrust of the shaft, when supported by the roller bearings, it was necessary to interpose 2 ball thrust collars. Before this was done excessive vibration of the motor and of the apparatus resulted from the tendency of the shaft to move endwise. This was particularly troublesome at high loads and speeds. The power was measured by the ammeter voltmeter method.

The manner of making a test or run was essentially as follows: Each night, the plant was run from 3 to 12 hr. under the load and speed to be used in the run of the following day (but without observation), the purpose of the (preliminary) night run being to allow the shaft and bearings to adjust themselves to the condition of the run, quite necessary as explained later. Then on the following day, the shaft was run from 3 to 6 hr. and frequent observations of power and temperature were made during the run. The first few observations were made as often as practicable, about 5 min. apart; the others, generally at 15-min. intervals, but toward the end of the run when the temperature was rising slowly, the interval was generally 30 min. or more.

Two lubricants were used in all the tests: Atlantic Red Engine Oil in the babbit and roller bearings, and No. 2 Keystone Grease in the ball bearings. Tests of the oil gave the following results:

At temperature, deg....	74.5	79	86.5	90	107.5	116	124	131
Viscosity	8.86	7.92	6.06	5.47	3.73	2.98	2.66	2.43

Flash point, 400 deg.; chill point, 32 deg.; burning point, 470 deg.; specific gravity, 0.905.

TABLE I. RELATIVE AMOUNTS OF POWER CONSUMED IN FRICTION

Bearings	100 Feet per Minute		300 Feet per Minute	
	77 Deg.	100 Deg.	77 Deg.	100 Deg.
Ball	1	1	1	1
Roller	2.2	2.5	2.7	3
Babbit	3	3.6	4.5	4

Figure 2 in the Practical Reference Tables shows the power-temperature curves for the bearings. Each curve shows how the power required per bearing to run the shaft varied with the temperature for the load and speed indicated on the curve. The solid lines represent results of continuous runs made; the extensions to "drop-down points" are dotted. For 150 r.p.m. the power does not vary much with the temperature; at the highest load on babbit bearings (2230 lb.) the point of minimum power for those conditions had been reached and the power was rising with rise of temperature. At the higher speed the drop in power with increase of temperature is very decided, about 50 per cent in the entire run.

For all conditions of load and speed the power decreased with increase of temperature, but the rate of decrease at the highest load and speed was not so marked as in the case of the babbit bearings. At the lower speeds the power for the ball bearings does not vary at all with the temperature, practically speaking. Before the ball bearing tests were begun, the shaft was run in the bearings for about 100 hr. in order to settle it down to as good running conditions as had been obtained in the earlier tests.

Figure 3 shows the coefficient of friction-temperature curves for the 3 kinds of bearings. The coefficient for roller and ball bearings was computed just as for babbit bearings from the formula

$$F = \frac{\text{(watts per bearing) } 531}{dn\ \text{(Load per bearing)}}.$$

where F is the coefficient, d the diameter of shaft in inches, and n is the number of revolutions per minute, 1 watt being equal to 44.26×12 or 531 in.-lb. per minute.

Figure 4 shows the coefficient of friction-speed curves for babbit bearings at 77 deg. and 100 deg. temperature; Fig. 5 those for roller bearings; and Fig. 6 for ball bearings.

Figure 7 and Fig. 8 show a comparison of the babbit, roller and ball bearings for 100 deg. and 77 deg. respectively. Each curve gives the power required per bearing of the kind indicated to run the shaft under the load and speed indicated. Both figures show that the power for the babbit is higher than for the other bearings except perhaps at low loads and speed, and that the power for rollers is higher than for balls. The excess of power for babbit over rollers and rollers over balls increases with increase of speed for all loads. Table 1 shows the relative amounts of power consumed in friction by the 3 kinds of bearings at the speeds and temperatures indicated; the relative numbers are based in each case on the average power for 3 loads: 710, 1210, and 1710 lb. for balls; 740, 1240, and 1740 for rollers; and 730, 1230, and 1730 for babbit.

Figure 9 presents the comparison in another way. The ordinates are coefficient of friction instead of power as in the 2 preceding figures. For babbit and roller bearings there is a marked difference between the average coefficient for the first hour and for the second hour. Thus in one run with babbit bearings, the average coefficient for the first hour was about 0.0058 and for the second hour about 0.0048. Hence the energy wasted in friction in the first hour was about 20 per cent more than in the second hour. This effect is less marked with roller bearings.

Figure 10 shows a comparison of rise of temperatures for the 3 kinds of bearings. Curves A and B were obtained from simultaneous tests on 8 babbit and 12 roller bearings. The room conditions, therefore, as well as load and speed were identical for both kinds of bearings. Curves C and D were obtained from simultaneous tests on 12 roller and 8 ball bearings respectively.

Breakdown Tests

In order to observe the performance of the bearings under extraordinarily heavy loads, breakdown tests were run on each type of bearings with only one section of shafting on which were 4 bearings. This small number of bearings was used because it was impracticable to keep close watch of a larger number of bearings and avoid trouble during the excessively severe conditions. The maximum load was 600 lb. on the scales, or about 5000 lb. per bearing.

These tests began at about 3200 lb. per bearing and 200 r.p.m. Failure occurred at about 4250 lb. per bearing in the case of the babbit, 4650 lb. in the case of the ball bearings, and about 5100 lb. in the case of the roller bearings. The quality and amount of lubricant used undoubtedly have an important effect upon the load that will cause a given bearing to fail.

The bearings did not in any case "fail" structurally, as the power was cut off soon after distress was manifested, but the failure was simply of the lubricant. Breaking down of the lubricant results in an immediate increase of the power required to maintain the original speed of rotation of the shaft in the bearings. In each case probably only one of the 4 bearings used in the breakdown tests showed distress at any one time. The bearings were not injured by these endurance tests, and all were used in subsequent tests at the more usual speeds and pressures.

The Ammonia Condenser

TYPES, SIZE AND CONSTRUCTION; POINTS TO BE OBSERVED IN ITS OPERATION; COOLING TOWERS AND THEIR CONNECTIONS. BY A. G. SOLOMON

THE ammonia condenser is a most important part of the ice plant, both for successful operation and economy. The construction and size of the condenser must be such as to meet the requirements of the plant. They are of 3 distinct kinds: Atmospheric, double-pipe and submerged. The first named is the general favorite, on account of its simple construction, ease of inspection and repairing, and by the advantage gained by the outside weather conditions. They are, as a rule, placed on the roof or on a tower built outside and high enough to get the benefit of any breeze there might be blowing.

Most of this type are made with the gas entering the top pipe and traveling down to the bottom. The objection to this is that the cooling water is somewhat heated by flowing over the hot pipes first. Other makes are so constructed that the hot gas enters at the bottom and by this arrangement the counter-current water effect is taken advantage of, as the coldest water flows over the coldest part of the coils and the heated water strikes the hottest coils. In this style the liquid is drawn off from each coil in 3 or 4 different points as it is condensed.

Another common form is for the hot gas to enter the third pipe from the bottom and travel down through 3 pipes and then, by a loop connection, to go to the top of the coil and again travel down to the fourth pipe from the bottom, when it enters the liquid line.

Another arrangement which is sometimes used has certain good points in its favor. A coil of 3 pipes is laid flat in the condenser pan and kept submerged, and after the gas has traveled through, it goes to the top, as in the aforementioned loop type.

DOUBLE-PIPE CONDENSERS

NEXT, IN order of common use, is the double-pipe condenser. This is used in a great many places and is recommended by its quick action of liquefying the gas owing to the small open space between the inner and outer pipe. It does not take much room and can be set up almost any place. It is advisable to have it where there is air circulation, but they are often found right in the hot engine room, where they give good service, although working against hard conditions. The counter-current effect of the cooling water is taken full advantage of, as the coldest water enters the inner pipe at the opposite point of the coil from where the hot gas enters the ammonia space. The gas enters at the top and has a downward flow, while the water enters at the bottom and discharges at the top. The 2 top outer pipes of each coil are larger than the rest, so as to give more space for the gas when it first enters.

SUBMERGED CONDENSERS

THEN WE have the submerged type, which is not in great demand. In this type the coils are entirely submerged in a tank in which the water is admitted at the bottom and overflows at the top.

There can be leaks in these coils and a lot of ammonia can be lost before they are noticed or located. And another objection is, this condenser is built so that one coil cannot be shut off from the rest.

DETECTING LEAKS

IN THE case of the atmospheric or double-pipe styles, each coil is provided with gas, liquid and pump-out valves, so that any coil can be cut out of service and pumped out and repaired without interfering with the operation of the balance of the condenser.

All condensers must be watched at all times for leaks and, no matter how small the leak, it should be fixed at once. By using a sulphur stick, the smallest leaks can be readily detected in places where the ammonia escapes into the atmosphere. Litmus paper will generally show leakage when the ammonia escapes into the water, as it often does in the double-pipe or the submerged condenser; but a leak can be quite large in an inner tube and the water absorb the ammonia so that the leak is difficult to locate.

If it is thought that an inner tube is leaking, I have found the following way satisfactory in finding it: Shut off both inlet and outlet water valves and the liquid ammonia valve of the suspected coil and let stand in this way for about ½ hr. In this way the water which is in the coil will become highly charged, and by drawing a sample and testing it, the leaky coil will be found. After the coil is found, the water return bends on one end must be taken off to find which inner tube is leaking.

When it is noticed that you are losing ammonia, it is a good idea to go at the condensers at once and not wait till you have lost several hundred pounds of ammonia.

The economy of the ice plant is going to depend greatly on the ammonia condenser. Install the style that will give the best results with the kind and amount of water available.

Water Required: Size Condenser

If you have water at a temperature of 60 deg., it will take about ¾ gal. per min. per ton of refrigeration. The amount of water and the size of condenser varies with the temperature, and this must be carefully studied to determine the amount of pipe necessary.

The following table will help:

Temp. of Cooling Water	Gal. per min. per ton refg.	Lineal ft. 2-in. pipe per ton refg.
50	½	30
60	¾	36
70	1	44
80	1½	52

The water should leave the condenser at an increase of from 10 to 15 deg., but this will vary with the weather conditions and the temperature of the discharged gas.

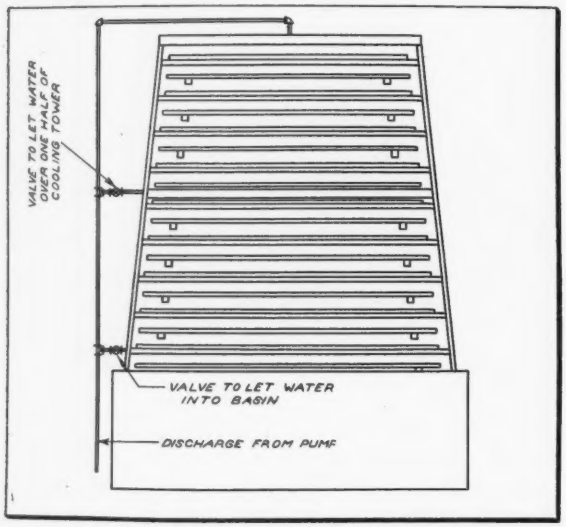


FIG. 1. CONNECTIONS FOR COOLING TOWER

If you have sufficient condenser surface in comparison with the temperature of the water, the fuel bill will be what it should be per ton of ice produced, if the other parts of the plant are properly proportioned.

By referring to your daily reports you can always notice when this producing cost varies, and then is the time to find the cause and remedy it.

Gas per Ton of Refrigeration

The following table will show the difference in the amount of gas handled by the compressor to produce 1 ton of refrigeration with different condenser pressures and a steady back pressure of 15 lb.; also, the horsepower per ton:

Con. Press. lb.	Cu. in. displacement per min.	Hp. per ton refrigeration
145	7829	1.2
165	8092	1.3
185	8362	1.5
205	8630	1.6

This displacement is for upright, single-acting compressors. For double-acting compressors it is a little greater.

By noting the increased displacement and resulting increased horsepower, it will be readily seen that the fuel consumption becomes greater with the raising of the condenser pressure.

In the cold weather, one or more of the condenser coils can be shut off, so as to give proper conditions for economic operation. No use to use all the coils in real cold weather, as you do in the summer.

Cooling Towers

There are very few ice plants that can afford to waste any water, so a cooling tower is a necessity. A good arrangement, is to have the cooling tower built on an elevation above the top of the ammonia condenser and pump the warm water over the cooling tower, where it will finally collect in a basin from which it is distributed over the condenser coils. Screens must be used over the openings of the water lines or sticks, drowned birds and other material will become lodged in the valves and shut the water off some of the coils.

In one ice plant we had to screen the entire condenser tower with wire netting, as we were so troubled with birds. They would come in droves every night and sit on the pipe and other places and fall into the water and drown, and at times we would be kept busy taking valve bonnets off and disconnecting pipe work.

Gas Binding and Scaling

Another cause of trouble in some plants is the way some of the condenser coils will become gas bound and store full of liquid which will not circulate. This can be overcome by regulating the water so that the coils that become blocked will get less water, and in this way the ammonia will be forced through. Sometimes this storing of ammonia will give a lot of trouble, and in real bad cases the dead coils will have to be shut off and pumped out before circulation is started.

By making it a habit to feel each coil when looking over the condenser, the troublesome coils are discovered before they get entirely full, and by shutting off the water for a few minutes they will go to work. Pay close attention to the condenser and do not allow the coils to become covered with dirt. Some water leaves a greenish, slimy moss-like deposit on the coils and this hardens into a scale if left alone.

Have a hose connection from a water line on which you can raise about 80 or 100 lb. pressure. Then, whenever any sediment is noticed on the coils, use the hose and do a good job of washing. It does not take long and will help to keep the condenser pressure down.

It is about impossible to keep the scale from forming on the coils of the submerged type, but during the winter season see that they get an extra good cleaning and scraping.

The water tubes of the double-pipe condenser must be flushed out regularly and blown with air once in a while. Also use a good scraper, made after the pattern of a common boiler tube scraper, and give them a good scraping if you think that it will benefit them even a little.

Keeping Clean

Cleanliness of the cooling surfaces of all condensers is just as important and money-saving as the cleaning of the heating surfaces of the boilers. I have learned, by years of rough experience, that if everything in an ice plant, both seen and unseen parts, are kept as clean as

attention and work can keep them, the reward gained by good, economic operation will be yours. If I were to choose a general motto that would fit all parts of an ice plant, it would consist of just 2 words, written in large, gaze compelling letters and posted in all places; the words would be "Keep Clean." It is a pleasure to work in and about a clean plant, but it is a satisfaction to know that the hidden and really important working parts are not prevented from doing their full duty by dirt.

All condensers look like a mass of bolts, flanges and valves, but none of these should be neglected. Each and every valve is important by itself. It is so important that when you want to close one, you should be able to do so without looking around for a wrench to move it with, and then for another wrench to tighten up the packing nut or gland.

Winter Work

Every winter, take the bonnet off every valve and see that the seat and disc are O.K. and not leaking. Pack the stems newly if they need it. See that the threads on the flange bolts are not half eaten off, and the bolts rusted nearly in two. Examine the condenser pipes, especially at the ends where the flow of water is somewhat irregular. This is a weak point in some places. I know of one case in particular where the ends of nearly all the pipe were eaten dangerously thin, close to where the flanges were put on.

In this instance, the condenser was taken down, one stand at a time, and 6 in. cut off each end of all the pipe. The weakened part only extended from 1 to 3 in. from the flange; but by taking off 6 in., the pipe was found to be full thickness, and good as new. Pipes were taken at random in different parts of this condenser and cut into 12-in. lengths for examination, but no defects were found.

Cause of Corrosion

This eating away of the pipe was explained in the following manner:

On most atmospheric condensers, the water does not flow over the pipes close to the ends. The distributing troughs are a little shorter than the coils. The water will splash or blow and the ends are wet in spots for a short time, and then they become dry again. This irregular wetting causes rusting and pitting, and when it once starts to eat into the iron the corroding goes on rapidly. It might take several years to affect the pipe to a dangerous extent, but it is best to examine this point, especially on old condensers. There are condensers in service today that were erected 18 or 20 yr. ago. The condenser that had the ends of each pipe cut off, had been in use over 20 yr., and that was the only defective part.

Another peculiar case was when pitted holes were found to form small pin-like holes through the piping of the liquid line and gas header, where water was splashed on them in fine particles.

If the wind has a tendency to spray water on a hot gas header, it is a good idea to make a protecting cover of galvanized iron or some other material to protect the pipe from this pitting that will be sure to start and eat through.

Clamps should always be on hand to put on condenser piping in case of a pitted hole, or even a split pipe. There are several good, handy clamps on the market that are cheap and serviceable.

Connecting Lines and Their Uses

The discharge line from the compressor to the condenser should be fitted with a check valve which will keep the charge of ammonia from escaping in case of an accident to the compressor, such as knocking out a head by the breaking of a suction valve. This check valve must have a bypass connection which can be used to pump out the condenser through the discharge line in case of emergency.

Most condensers are provided with an equalizing gas line or, as it is sometimes called, a pump-out line, which is connected to the top of each coil and also to the suction side of the compressor.

It is also generally connected to the top of the liquid receiver to let the light gas return to the condenser.

This equalizing line is provided with a valve opening to the atmosphere to purge the condenser of air, or what is properly called, noncondensible gases. These gases are noncondensible and, therefore, occupy considerable room and are a serious drawback to the successful operation of the plant. They should be blown off whenever noticed. Their presence is noticed by increasing condenser pressure and by whistling noise at the expansion valves. This gas will travel around through the system and will have to be handled by the compressor which reduces the efficiency of the compressor displacement.

To purge the condenser, the first step is to pump down all the ammonia from the low-pressure side and store it in the condenser and liquid receiver. To do this, close the valve on the liquid line between the receiver and the expansion valves on the ice tank. Pump down till the back-pressure gage is at the zero mark. While pumping down, the condenser pressure must be watched closely, for you might not have sufficient room for all the ammonia. If the pressure goes beyond what you consider the safety limit (in some plants this will be 210 lb., while in others, 260), stop the machine and let the water flow plentifully over the condenser for an hour or more. This will condense the ammonia, and the light, noncondensible gas will go to the top of the condenser. The machine should be run slowly after the back pressure gets as low as 7 or 8 lb., or the cylinder will not have time to fill with gas, owing to the reduced pressure and the resistance of the suction valve springs.

Next, close all the valves on the condenser that connect with the pump-out line, and put a piece of pipe or hose from the purge valve and extend it into a pail of cold water. Open the purge valve a turn or two and then begin at one end of the condenser and crack the equalizing gas valve on one coil. Keep this open slightly till the gas is all out, and then close it and continue this operation till all the coils have been purged.

The air will appear in the form of bubbles rising in the pail of water. When ammonia comes, it will cause a slight but distinct crackling sound when it hits the water, or the water will assume a milky appearance. After a few trials you will not lose a particle of am-

monia and be able to get all the air out. The water in the pail must be changed from time to time, as it becomes strong with ammonia fumes.

An experienced person need not use the water, but can tell when the ammonia blows out of the open end of the pipe. The noncondensible gas is practically colorless, while ammonia vapor is white.

After all the air is out, you will notice a reduced condenser pressure and a better working of the machine and expansion valve, and improved conditions in every way. Don't burn fuel to handle gas that does no good and only wastes power to pump.

Provision for Continuous Purging

This noncondensible gas can be removed from the liquid receiver by the following arrangement, which can be used continually and will keep the system free.

If the receiver is fitted with a gas return line the connections are easily made, but in some few places this return line has not been put in. In that case, the top head of the receiver is drilled and tapped for a ½-in. pipe. Put a ½-in. nipple in first, and then a globe valve. Next, either purchase or construct a

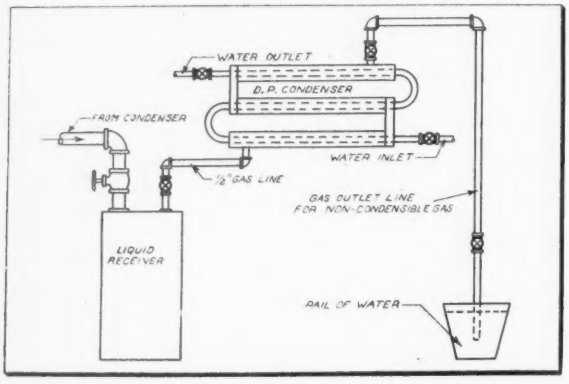


FIG. 2. CONTINUOUS NONCONDENSIBLE GAS EXTRACTOR

double-pipe condenser, which need not be at all large; say, 2 or 3 pipes high and 6 ft. long. It is best to have this condenser standard size; that is, 1¼ pipe inside of 2-in.

This condenser can be hung on brackets on the wall close to the receiver. Pipe the ½-in. gas outlet from the receiver into the bottom connections of this condenser, and put a ½-in. valve at the top or outlet opening. Extend a ½-in. pipe from the outlet valve to the floor and have it end in a small tank or bucket which will be kept full of water.

The water connections for the inner tube should be made the same as on the regular double-pipe condenser; that is, inlet at the bottom and outlet at the top. There is not much condensing to be done, so very little water is required.

Now, while the plant is in continuous operation, the valve on top of the receiver is left wide open, and the valve at the top of the small condenser is cracked just enough to let the gas escape in the form of bubbles, into the water in the pail.

If the system ever gets free from this objectionable gas, and the gas extractor can be shut off and used again when deemed necessary. I am of the opinion that it will never be entirely shut off.

By the foregoing explained arrangement, any smallest particle of condensible gas that gets into the small condenser will be condensed and flow back into the receiver.

Ammonia Purifiers and Safety Devices

The ammonia purifiers or generators which are in general use all over the country are excellent for recovering oil and eliminating so-called dead liquid, but they do not take care of noncondensible gas. All apparatus which keeps ammonia in a pure, clean and condensible form at all times, is a money-saving investment and should be at least investigated.

Safety devices, such as shut down the ice machine with increased condenser pressure, or those that shut the ammonia off in case of failure of the compressor, are just as important in the plant as nonreturn steam valves are on the boilers. These devices might never be called into service, but if they ever are needed, they will be needed badly.

All valves on the ammonia discharge line, from the compressor to the condenser, must be put on with the pressure side to the compressor. Neglect of this precaution has been the cause of many of the most serious accidents that have happened to the ice and refrigeration plants. No matter how well a valve is constructed, the disc might come loose or even break off the stem, and if the valve is put on wrong, the discharge will be closed.

Cold-Weather Considerations

In a cold climate, the ice which collects on the atmospheric condensers is another source of work and danger. Do not let the ice accumulate on any part of the condenser, or roof or cooling tower. The weight can become so great that pipe can be broken off or even the roof cave in.

Use as few condenser coils as you can during cold weather and give them an abundant supply of water. This is one good way to keep ice from forming in large quantities.

When a cooling tower is used it should be so arranged that only a part of it need be used in cold weather, or it can be cut out entirely, if so desired. The discharge from the pump should have a tee and valve at the basin under the cooling tower; by opening this, the water is allowed to go directly to the ammonia condenser without passing over the tower. Halfway to the top of the tower, this arrangement is again put in the pump discharge and only the lower half of the tower is used.

With double-pipe condensers there is always danger of freezing and splitting the inner tubes. Watch the water circulation closely, so that some of the tubes do not get partially blocked in some way and the water freeze even when the circulation is supposed to be good. If the machine is shut down, use air and blow out the inner tubes of each coil separately, to be sure that they are clear and empty.

Don't take any chances; it is much better and easier to take extra precaution and do extra work to prevent a freeze-up than it is to remedy the trouble after it has happened.

Withdrawing Charge of Ammonia

A few pointers on withdrawing a charge of ammonia from a plant might come in handy for those who have never had this task to perform. First, secure enough empty drums and pump a vacuum of at least 20 in. on each. Do this by connecting the drums to the suction side of the compressor. Next, pump down the system and get rid of the noncondensible gas. Put a drum on a scale and note the weight; then, by suitable connections, draw out of the receiver till the drum contains about half as much as it is supposed to contain when full. When no more ammonia can be drawn from the receiver, shut off and pump out ¼ of the condenser coils and discharge into the remainder. Repeat this till all but one coil has been pumped out. Run the machine very slowly and watch the condenser pressure, for at the last you are discharging into only one coil. By doing this job slowly and carefully, all of the ammonia except a few pounds of gas, will be put into the drums. Then store the drums in a cool place, or ship them to the manufacturer, where the ammonia will be regenerated and you will be given credit for all that is any good.

Fusible Plugs

IN an issue of The Locomotive, the question of fusible plugs and their location is discussed, and as a number of our readers have made inquiries in regard to these points we think it worth while to abstract the article at some length.

The true function of a fusible plug is not to save the boiler from an explosion or from overheating, but to act as a low-water alarm and call the attention of the boiler attendant, so that he may take the necessary steps to save his apparatus. Usually the plugs are of brass with a hexagonal head at one end to permit of screwing them in with a monkey wrench, and are threaded with a standard tapered pipe thread. They may be made to screw from either the inside or outside, but in either case a tapered hole is drilled through the center of the plug so that the large end of the hole will be toward the water side of the sheet when the plug is in place. This hole is then filled with fusible metal which will be crowded tightly into it by the boiler pressure.

As long as the inner end of the plug is covered by water it will remain at a temperature practically the same as the water and the fusible metal will not soften. If the water level falls so that the plug is not covered, and there is no longer anything to carry away the heat given to the plug by the fire, the metal in the tapered hole will soften and be blown out.

In order to have it effective, the plug must be filled with a material whose melting point is but little above the temperature of the water in the boiler at working pressure, and one which can be depended upon to flow out at a fairly reliable melting point. Alloys have been used to a considerable extent, but all of them are subject to a slow change, particularly when exposed to the action of the gases on one side and the water on the other. For this reason it has been found that a pure metal is more stable. Banca tin is usually used and will remain in serviceable condition longer than any other material whose melting point is at all suitable. This may be depended upon to melt promptly at about 450 deg. F., which corresponds to a boiler pressure of 365 lb. gage. Even the tin will, however, undergo deterioration in service, and cases have been found where the metal became oxidized at the ends. The metal should be clean, soft and malleable when struck with a light hammer.

Not only on account of inspection, but also so that it may be easily replaced, the plug should be in an easily reached position. Plugs have been found filled with wrought nails, or even an ordinary pipe plug substituted, where conditions were such that the plug blew somewhat frequently and could not be readily replaced. In a vertical tubular boiler, except of the submerged head type, the plug must be located in a tube, to be of service. A hand-hole is usually placed in the shell opposite the plug which must be screwed into one of the tubes in the outer row. With the tubes commonly used, a very small plug is required, but the boiler must be quite cold and emptied below the hand-hole level before a plug can be replaced. This evidently takes time and is troublesome, so that the use of a plug in this type of boiler is at least a debatable question.

As to the location for various types of boilers, wherever legal requirements have been adopted, they should be accurately followed, as a failure to do so may involve the boiler owner in serious difficulty. A general rule would be to place the plug at that level below which the water line should never be allowed to fall, even in an emergency, when there is a fire on the grate. Place it in the most accessible location which will satisfy the first requirement, and by accessible we mean easily reached from both fire and water sides, if possible. The third and last requirement is, that the plug be as near the furnace as it may, so that it may be heated to the fusing point in the shortest possible time after being uncovered.

Perhaps it may be well to illustrate this rule with a few typical plug locations in familiar types of boilers. In internally fired boilers of the locomotive, Cornish, or Lancashire type, the plug is usually located in the furnace crown about an inch, so that it will be uncovered before the crown sheet is entirely dry. In Scotch marine boilers of the wet-back type, the plug would be located in the top of the combustion chamber, while in the dry-back type of Scotch boiler, the plug is placed in the back tube sheet 2 in. above the top row of tubes.

In the horizontal tubular type, the plug is placed in the rear tube sheet or head, 2 in. above the tube tops. In water-tube boilers the plug is placed, if possible, in the steam drum at the lowest permissible water level, and, if possible, in the first pass of the gases. An access door in the setting opposite the plug is of great assistance in this case. With those water-tube boilers, in which vertical or nearly vertical tubes terminate in an upper drum, the fusible plug is usually placed in the lower head of this upper drum. One additional caution is necessary in the case of water-tube boilers with regard to the level at which the plug should stand. In many of these vessels the tubes terminate in the upper drum, and are secured to it by a rolled or expanded joint. In such cases the fusible plug should be high enough so that the tube ends will still be covered when the boiler plug operates, for if these tube ends are overheated, all the tubes in the boiler may be ruined.

LETTERS DIRECT FROM THE PLANT

Cash Paid For Ideas Accepted. Sketches Desirable.
We Make The Drawings

Explosion of Locomotive Type Boiler

WHAT I would call a very remarkable boiler explosion occurred here recently. Description of boiler was as follows: Forty-five, rated horsepower; locomotive type; diameter of shell, 42 in.; plates, 3/16 in. thick; flue sheets, 3/8 in.; crown sheet, 3/16 in.; crown sheet and water leg staybolts, 7/8 in., spaced 5 by 5 in.; shell rivets, 5/8 by 2 in. pitch in girth seams; shell rivets, 3/4 by 2 7/8 in. pitch, staggered riveted lap joints in longitudinal seams; dome, 40 by 40 in., flat top, with 30 7/8-in. stayrods with upset ends from top to crown sheet; dome shell, 5/16 in., singly riveted to shell with 3/4-in. rivets, pitch 2 in.; 60 3-in. by 11-ft. tubes; grate surface, 40 by 46 in. This boiler was in service only 3 months, and was run in a battery with another of similar type. It was used on a drilling well in the oil fields of California, on a rotary type of well-drilling apparatus, and furnished steam for a 11½ by 12-in. drilling engine, running at its uttermost limit, and a 10 by 5 by 12-in. duplex circulating pump, against about 150-lb. pressure, and sometimes more, for the pressure would cause the pump to stall.

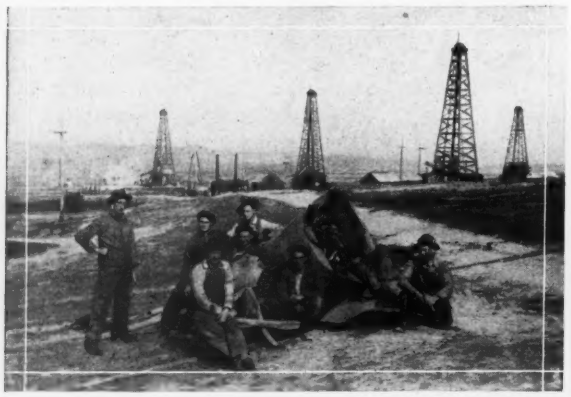


FIG. 1. DOME OF EXPLODED BOILER

FIG. 2. FRONT OF DESTROYED BOILER

There were 10 men and 1 span of mules within the radius of 50 ft. of the boiler at the time it exploded; no one was hurt or killed, though it shook a school house, 12 mi. away, so hard that the children and teachers were about to vacate it.

This boiler was number 1; number 2 had been shut down for a washout, when all of a sudden it popped off, for the first time in its history. The fireman went to investigate, and the gage read 40 lb. Blaming the safety valve, he went to the drilling rig, got a wrench and screwed it down. Up went the steam to 70 lb. Up he went again and, as he said, he gave her all there was, and started back for the rig, which was shut down on account of a break in a chain. He started back for the boiler, when the driller hailed him for a lift, which took about 5 min., and just as he was starting back the second time, the report came.

The boiler surely reached its bursting pressure, for I examined the fusible plug in the crown sheet, which was O.K. In Fig. 1 is the dome with the right half of the outer water leg shell and part of the mud ring. Note how the dome tore away from the shell to allow a man to enter. Also note how the shell tore at +1. This piece was thrown straight back 1460 ft., and weighs about 1200 lb. The point marked X is where it came from. Figure 2 is the front half of the shell, with front tube sheet, in which there were only 9 tubes; the other 51 were scattered about, in a radius of 1000 ft; 2 tubes at XX. Note how the extension end flanged inward, almost upon itself, although apparently it struck nothing. This piece landed 480 ft. forward.

The back tube sheet dropped right down where the boiler stood; the crown sheet and inside firebox sheets went 70 ft. to the right; the back end and firebox sheet went 926 ft. back; the left outer half of the water leg shell went 530 ft. to the left; the throat sheet and tapered section of the shell went about 700 ft. forward; the firedoor was found about 50 ft. to the left of the dome, in Fig. 1. A guy wire of 1 of the rigs was in its way and was taken along, as can be seen.

The safety valve, steam gage and water column have not been found, but I think they dropped in an oil sump hole, of which there are a number.

It turned over the boiler beside it, which was 10 ft. away, broke the feed pump, and sent a 10-bbl. water tank 200 ft. to the right.

Fortunately, no other damage was done, although it took $1000 to cover the losses. It goes to show what kind of a mess the "Kid" engineer can get into outside of setting valves on a Corliss. WM. MALESKI.

How Rope Drives Wear Out

ON PAGE 269 of your Feb. 15 issue, there is an article headed, "How Rope Drives Wear Out."

The writer makes the statement: "Some engineers entertain the idea that a power transmission rope will display external evidence of wear before failure is imminent," proceeding to argue that it is not the case. He takes the view that "Failure usually begins at the core, where the severest rubbing of the fiber against the fiber occurs."

In some instances this statement may be correct; but in the majority of cases, where the rope drive is properly designed, there will be no internal wear, and when the rope finally fails, the exterior will show defects when there will be no visible evidence of weakness at the core.

When ropes wear internally, the fault is not in the rope, but may be due to the wheels being too small for the diameter of the rope, or the tension of the rope being too great, or both. Power transmission ropes that are properly designed sometimes come in contact with stationary objects, as in passing through partitions, or a floor, where the opening is not large enough to clear the rope which may vibrate at times, striking the sides, as in starting the engine, or from fluctuating load.

The friction of a rope against a stationary object will wear the fiber of the exterior rapidly and cause deterioration when no external wear is noticeable.

This will also cut the fibers in a splice where the "tucking" is slightly larger than the "lay" of the rope, causing a strand to loosen and fray out. When ropes wear externally, as described, they will be rough to the touch, as if full of needles, and should have immediate attention to discover and remove the cause. This expresses our viewpoint as a designer and manufacturer of rope drives for 31 yr. DODGE MANUFACTURING CO.

Cleaning Atlas Water-Tube Boilers

I SEE in Feb. 1 issue of Practical Engineer how A. G. Solomon cleaned B. & W. boilers, so I will tell how I cleaned Atlas water-tube boilers.

At one time I had charge of a steam plant consisting of 6 400-hp. horizontal water-tube type. When I began, all 6 of them were required to carry the load and then at times it was required to shut down one engine to clean fire. At one time a few tubes had been left leaking a long time, and this caused the draft to be almost choked off by soot and ashes sticking in the tubes.

I replaced the leaky tubes with new ones and we shut down in winter, as we usually did each year, for repairs. (It was a plant for manufacturing Portland cement.) I had a man take small rods and hooks, get in over the tubes and under them and knock and punch out all of the soot and ashes from among the tubes of all boilers, thus giving good draft. The water formed quite a good deal of scale in boilers, and while the plant was down for repair, we had 2 gangs of men running 2 water turbine scale removers working day and night boring out the tubes. This took 4 men (2 to each machine each shift) about 3 weeks, all working 10 or 12 hr. each per day. One can imagine what it was like, when each boiler has 180 tubes. When we started the plant again the load was carried fairly well on 5 boilers without shutting down any engine to clean fires, where it required 6 boilers before and a stop to clean fires. This resulted in using less coal and more easily keeping coal wheelers and firemen. The saving in coal soon paid all extra help in cleaning tubes when the plant was down for repairs. Five boilers being all that were required to carry the load, left one boiler down for cleaning and repairs all the time. We tried, after this, to use a good grade of boiler compound all the time and run a turbine scale remover through each tube every time the boiler was down for cleaning, which was about every 5 to 7 weeks. My plan for cleaning after this was to stop firing a boiler to be cleaned at 7 or 8 o'clock p. m. and cut out as soon as the boiler quit making steam. About 5 o'clock the next morning I had the night man open the blowoff valves, drain the boiler and wet down ashes in the ash pit. About 7 a.m., 2 men would take off the hand plates on the front ends and run the turbine through each tube and, with this way of cleaning every time, there was not much scale in the tubes, and what there was, was easily taken out. Often the 180 tubes of each boiler were bored out and the boiler headed up in one day by the one boiler cleaner and his helper, with what help I could give and attend to other work.

We had a pump governor on the pump that furnished the water for running the turbine, so there was not much danger of blowing a gasket or bursting a turbine hose. If we were in a hurry for the boiler, I got 2 men to clean and wheel ashes out of the soot pit, or combustion chamber, which required from ½ to ¾ day for each of 2 men. If not in a hurry, the boiler cleaner and helper cleaned the soot pit. If any brick work was to be done, the brick mason was called and when cleaning the tubes was completed, the mason went to work repairing brick work while the men headed up the boiler. We always kept a good supply of lead gaskets molded and shaped to fit on heads or hand plates of boilers. All of the 180 hand plates were taken off the front end and only 6 or 8 on the back end, just enough to let water and scale out behind. We only used a lead gasket once and then had it remolded; thus, the cost for gaskets in this way was only about ½ what it was formerly when asbestos gaskets were used, and the lead gave much better service. The boiler cleaner and his helper blew soot off the tubes and swept, cleaned windows, and helped with repair work and also helped in the oil house when not cleaning boilers.

By keeping after the job from 1 to 2 days (maybe 3 days was the longest time required) we took off a boiler, cleaned, repaired and had it ready to fill with water; so it is the neglect of cleaning properly and cleaning in proper time that makes it so difficult to clean water-tube boilers. The headers of the Atlas boilers are of boiler steel and therefore gave no trouble about cracking, as do the cast-iron headers such as were described by Mr. Solomon.

Leaky tubes are removed much in the same way he described; all leaks, packing of valve stems, leaky cocks

and valves are attended to, at the time the boiler is down for cleaning; also floats in the water column are changed if needed. The Atlas boilers each have 2 blowoff valves, one from the lowest part of rear header and one from the back drum or feed-water drum, where the feed water enters the boiler. A mud pan is in the drum and requires cleaning out also. The blowoff valves have brass seats with babbit metal discs; these discs are changed and seats examined each time the boiler is cleaned; these seats are also molded at the plant at small cost and the question of leaky blowoff valves is quite easily settled.

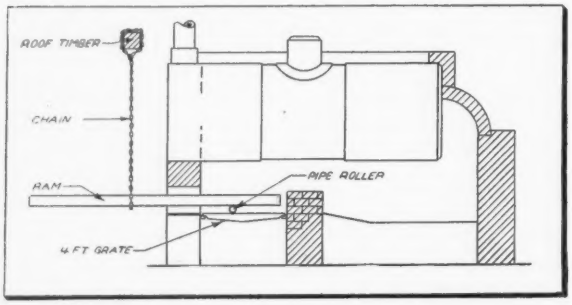
We had no air system, but we used steam at 130 lb. gage pressure to blow tubes. The water foamed and primed very badly, as well as made scale in boilers; also ate up the feed-water pipe badly, so that the pipe had to be renewed in about 3 yr. after the plant was built. The theory of the chemist was that the acid in the water passed off with the steam when it entered the boiler and got hot enough to do so, but while in water form, had an effect on pipe and pump, also heater.

I always kept close watch on all cleaning and repairs, and did not trust too much to what someone else said about what had been done. O. L. HARPER.

A Backwoods Sawmill Plant

I HAVE just read F. M. Johnston's description of a modern sawmill plant, of which I have seen a few; but there are hundreds of the other kind to one of his. You will find them from 15 to 200 hp., portable and otherwise.

Some 15 yr. ago in Vermont, there was a plant of 75 hp., R. T. boiler slide-valve engine, Hancock inspirator, a feed-water heater not in use, also a duplex pump the worse for wear, which had not been connected for lack of fittings. The owner's brother, a boy of 17

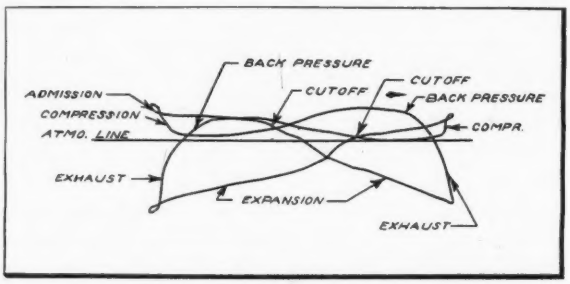


BATTERING DOWN THE BRIDGE WALL

yr., was the engineer. Coal had to be hauled 10 miles, as they couldn't make much steam on green slab wood, and at that they had to shut down to fill the boiler. The owner, hearing of an engineer out of work, and of some experience, made him this offer. The owner would pay him $2.50 a day, providing he could save that amount over $1.50, the present engineer's wages. The engineer agreed to go for half what he could save above the present engineer's wages, but what he did get was $3.00 a day. First day on the job, he fired coal and shut down 4 times to fill the boiler. That night he rigged a ram with a log and chain and knocked off top of bridge wall. The next day he fired coal and slab wood from 8 to 12 ft. long, with the usual shut-downs to fill the boiler. The next day, he sent for fittings and repairs for the pump. After getting pump and feed-water heater connected, he burned nothing but slab wood, with no shut-downs to fill the boiler and when the safety valve blew steam through cracks in a partition onto the sawyer, he jumped into the river. All the mill hands were sure the boiler had exploded. B. C. WHITE.

Card from Engine in Distress

THIS CARD I got from a tandem compound 20 and 34 by 42-in. engine. It was taken just after losing the circulation water which caused the engine to go high pressure or noncondensing. I have marked the different events of the card so that they can be followed out. I would like to see more cards taken while engines are experiencing trouble. A. C. WALDRON.



THE INDICATOR MADE THIS DISTRESS SIGNAL FROM THE LOW-PRESSURE CYLINDER

Knock in Engine

IN THE issue of Feb. 15, is A. G. Solomon's article under the above heading. I gather from his statements that he is of the opinion that compression is governed partly by the amount of steam the engine uses, as in one instance he says: "With a heavy load, the engine has compression enough, owing to the large amount of steam required to do the work."

Now, the writer has always been taught that compression remains constant in a Corliss engine as long as the back pressure does not vary, which, of course, is correct.

The amount of steam the engine uses, short or long cutoffs, light or heavy loads, high or low steam pressures, have nothing to do with compression, unless they alter the back pressure.

It can be altered in the high-pressure cylinder by changing the receiver pressure—which corresponds to this cylinder's back pressure—which, no doubt, will take place with a change in load, or initial steam pressure. But this altering of the receiver pressure—which is the low pressure cylinder's initial pressure—cannot affect the compression in the low-pressure cylinder.

The only way it can be changed is to vary the back pressure, which may be above or below atmospheric pressure. Of course, this has reference to a given valve setting, as changing the time of closing of the exhaust valve will alter the compression.

In the plant where the writer is employed are 2 cross-compound Corliss engines, direct connected to 1500-kw. generators.

The low-pressure side will sometimes pound on the quarter when running light and carrying low receiver pressure, if there is much slack in the crank and crosshead pin brasses. When properly keyed up, this does not occur.

It has been reasoned out that when this pounding occurs, the cutoff is short and receiver pressure low; consequently, when the crank on the low-pressure side is in the neighborhood of the quarter, the pressure in this cylinder is very low. At this point the high-pressure cylinder takes steam and forces the low-pressure pins from one-half of the brasses over to the other half, with the resulting pound, the magnitude of which depends on the amount of space in the brasses. In other words, the crankpin tends to pull the piston instead of being pushed by the latter, due to insufficient pressure behind the piston to give it the required speed. JOS. STEWART.

Taking An Examination

J. E. K.'s LETTER, page 275, Feb. 15 issue, is certainly interesting in several respects. I would like to give expression to some of the thoughts that came to me as I read that letter.

In the first place, the fireman who is the central figure in the story, evidently studied his lessons by "rote," as we say; that is, he probably learned by committing to memory certain rules and statements that would be required of him at an examination. But it is also evident that the examiner suspected that his candidate had learned by rote, so he swerved aside to ask a question that was not expected, but was perfectly fair, and the candidate could not answer it. The fact that he could not answer that question (see letter, page 275, Feb. 15) shows that he did not know very much about the subject, in spite of the amount of coaching he got, and the time he had spent in learning the questions and answers, as you would learn a verse or poem.

The point I want to emphasize is this: Engineering cannot be successfully learned by the catechetical method alone. The question and answer scheme is safe only to those who have acquired a good, solid knowledge of elements and principles, and then they will know just how far they may trust in answers to certain questions. But to the man who does not understand elements and principles, the short-cut route of questions and answers may, in some cases, be positively dangerous to pursue. I do not wish to be misunderstood. The questions and answers columns of technical papers are very helpful, when properly used and understood, and no such paper would be quite complete without that department. The various engineering catechisms are also good, and they serve a useful purpose. But neither of these will serve the purpose of studying the elements and principles of steam engineering.

Had the fireman understood the principles involved in valve gear design, and in the setting of valves, he could not have been mixed up by any ligitimate question the examiner might have given him, and had he been given an unfair or catch question, he would recognize such, and give the examiner to understand that he knew. Examiners seldom catch real students to their undoing, for they can always make suitable answers to any question. The purpose of an examination is to discover just how much or how little a person knows of any subject. If the person really knows his subject, it will be discovered, even if the questions are not answered in the "by rote" fashion. If he does not know his subject he can easily be found out, even though he does answer the routine questions in the manner given in the book.

I would like to suggest to fireman that he never again make answer that he knows "all that can be known" about any subject, no matter how simple it may be. Such a statement as that betrays the novice, and the fellow who has not gone very far. A wise man would never answer that way, no matter how much he might know of his subject. CHARLES J. MASON.

Pump Valve Trouble

SOME TIME ago I installed a duplex boiler feed pump. When all necessary pipe connections were made, the pump was started; after making a few strokes it stopped with steam valve nearly wide open. Upon examining the steam and water end of the pump, nothing was found which I thought could possibly cause the trouble. The pump was started again, but upon making a few strokes stopped again, so the pump was examined once more, but nothing found wrong. The pump was started again, but after a few strokes stopped.

I removed the steam chest cover, then I noticed that one of the slide valves was lifted off the seat and wedged tight between the 2 hexagon valve rod nuts, so the valve could not be moved; the nuts were adjusted, so there was a little lost motion; the pump was started and there was no further trouble.

The reason this was not noticed in the first place was because this pump is provided with means on the outside so the slide valves can be adjusted for a short or long stroke of the piston, and when looking for the cause of the pump's stopping, after making a few strokes, the water and steam cylinders were examined first, then the steam chest. During this time the slide valve and rod nuts had time to cool some and contract when the valve was loose; but when the pump was started again and made a few strokes, the valve, nuts and valve rod would expand when there was no lost motion between valve and valve-rod nuts. When opening the valve chest immediately after turning off the steam from the pump the trouble was found.

H. JAHNKE.

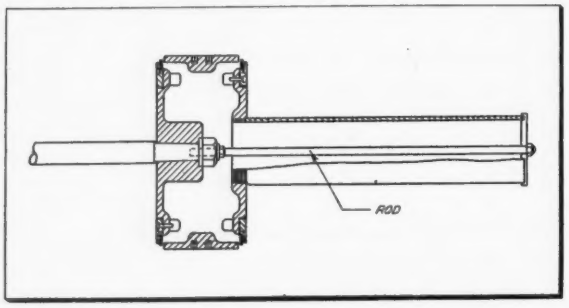
THE SPRING MEETING of the American Society of Mechanical Engineers will be held in St. Paul and Minneapolis, June 16 to 19. Tuesday evening will be devoted to the usual reception and president's address; Wednesday, both morning and afternoon, to professional sessions; Thursday morning, to a business meeting at the University of Minnesota; Thursday afternoon, to social intercourse at the home of Gebhard Bohn, on Lake Minnetonka, and Friday to technical excursions. It is proposed to have sessions devoted to grain handling and ore handling, a session on the uses of powdered fuel, and a third session for miscellaneous papers.

Successful Kinks From The Plant

For Saving Time, Work and Trouble

Repairing Air Compressor Intake

In the plant where the writer is employed, considerable trouble was experienced with the intake pipes on several air compressors working loose. In some instances the threads would wear off, necessitating a larger diameter pipe, an expensive piece of repair.



METHOD OF OVERCOMING INTAKE PIPE TROUBLE

Our troubles were finally overcome by screwing a rod into the end of the piston rod, extending it through the intake and using a crosspiece and lock nuts as shown in the sketch. These did not interfere with the intake, as the pipes are of ample capacity. A. Blom.

Belt Tightener; Hook Spring Adjustment

Figure 1 shows a governor belt tightener, which rides the belt, being suspended by rods from the bell crank or arm of the governor. It serves a double purpose, as it keeps the belt tight, and in case of the belt breaking, acts as an additional weight to pull down the governor.

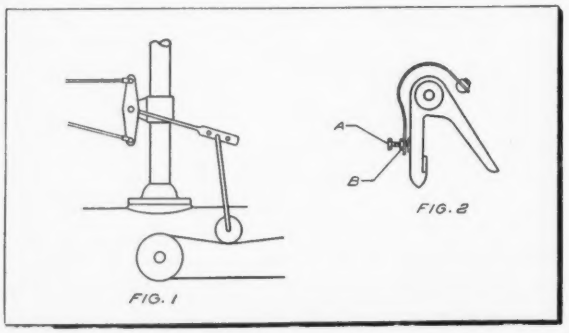


FIG. 1. BELT TIGHTENER WHICH ALSO ACTS AS AN ENGINE STOP

FIG. 2. SPRING ADJUSTMENT FOR VALVE HOOK

Figure 2 is a hook spring adjustment recently seen while traveling around; A is an adjusting screw, the end carrying a small plate. The tension on the spring is varied by working the screw in or out and locking it with the lock nut, B. H. E. G.

Covering A Separator

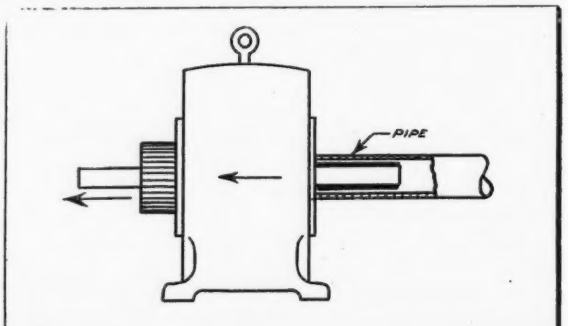
We had a large vertical receiver-separator placed on our engine, and had to cover it with magnesia. After making a few false starts on the job, this is the way we did it.

We got some wire fencing, such as is used for chicken yards, with a fine mesh, and covered the separator with this, keeping it, by means of blocks placed behind it, about ¾ in. away from the metal all around. It was securely fastened in position. The magnesia was mixed with water, somewhat soft, and thrown against the separator, with force enough to send it through the wire mesh, and stick against the metal.

After the separator was covered all over, we took a trowel and smoothed it up. Some unbleached muslin was then wrapped around it and pasted with a flour and water paste, after which a few brass bands were placed around it. When dry, the muslin cover was painted. Tom Jones.

Removing Motor Armatures

It was always a difficult job to take rotors out of our 20 to 60-hp. induction motors. By withdrawing the rotor it would rub on the winding and damage it and has also caused mashed fingers. Now we take a piece of pipe somewhat larger than armature or rotor



METHOD OF REMOVING THE ROTOR FROM A MOTOR FRAME

shaft, any length desired, cover the shaft with old belting or piece of rubber hose to prevent the shaft from being damaged, slip the pipe over the end which is to pull through the frame and the work is done easily.

Pete Burkard.

Substantial progress is being made in the plans of the new Mahoning County Light Co., for a new power station at Youngstown, Ohio, according to a statement by M. Liebel, Jr., of Erie, Pa., president of the new lighting company.

Questions Answered and For Answer

Expert Help When In Trouble. If You Want Quick Answer Enclose a Stamp

Two Refrigeration Questions

WILL YOU give the energy wasted with a 16 by 36-in., double-acting Vilter compressor, running at 0 and —5 deg. temperature, in 4 rooms well insulated with 5 in. of cork, each room containing 36,000 cu. ft., heavily piped with 2-in. pipe? I want to know the difference in loss between operating with 1 in. of solid frost on coils and with the coils kept clean. Would say that the average amount of poultry and butter going into rooms daily is about 4000 lb., and about the same amount is taken out. Do you figure that the expense of keeping the coils clean is less than when operating with the frost on coils—operating with these temperatures? These rooms are piped 1 ft. of 2-in. pipe to 8 cu. ft. of space. This compressor is working on another load as well as these rooms, and what I want to know is, the losses on these rooms.

The above machine operates as follows: Speed, 50 r.p.m.; suction pressure, 10 lb.; condensing pressure, 140 lb.; operates on low temperatures, frosting back to machine until discharge is running at a temperature of 70 deg. What is the difference between that and running the discharge at a higher temperature, say 200 deg.? I would like to have you advise which is the most economical way of operating. I am aware that we will have to cut down on the expansion valves to relieve the frost, also that coils will have to be cleaned in those rooms. W. C.

A. A 16 by 32-in., double-acting ammonia compressor, running at 50 r.p.m., will have a displacement of 72,360 cu. in.

Running with 16 lb. back pressure and 140 lb. condenser pressure, this compressor will be rated at about 112 tons capacity. With those pressures, the displacement is rated at about 6400 cu. in. per min. per ton refrigeration per 24 hr.

Now, the capacity will be about 87 tons if only 10 lb. back pressure is carried, as the displacement will then be about 8300 cu. in. per ton refrigeration per 24 hr.

The capacity of a compressor is rated on the amount of ammonia handled and decreases fast with the lowering of the back pressure.

For the cold rooms at 0 to —5 deg., the back pressure will have to be carried at about 10 lb.

Frost should be removed from coils whenever it gets heavy, as it acts as an insulation and the ammonia in a heavily frosted pipe will not take up the heat of the room readily.

This heavy frost will also account somewhat for the exceedingly low discharge temperature. Even with the expansion valves scarcely cracked, the ammonia that is admitted to the coils has small chance to evaporate, and will go to the compressor in a very saturated state. This liquid ammonia taken into the cylinder will occupy the clearance spaces, re-expand and keep some gas from entering, until the piston has traveled far enough to reduce this pressure below the suction pressure. Also, with a low discharge temperature, the condenser is not allowed to do its full duty. Keep the discharge temperature at about 160 or 170 deg. and you will get better results at less expense.

Four rooms of 36,000 cu. ft. each make 144,000 cu. ft. to be held at a certain temperature, as well as the incoming poultry which will have to be frozen. In rooms of this size and piped as they are, about 50 B.t.u. per cu. ft. per 24 hr. is required to be handled to hold the temperature. In this case, that will equal 7,200,000 B.t.u. or about 25 tons, allowing 284,000 B.t.u. to a ton.

We will assume that the poultry has a temperature of 40 deg. when put in the rooms and it is required to lower this to zero. The specific heat of poultry is about 0.8. For 4000 lb. poultry to be lowered 40 deg. in 24 hr. will require about 0.45 tons refrigeration.

$$\frac{(4000 \times 0.8)\ (40 - 0)}{284{,}000} = 0.45.$$

It is claimed that a heavy coating of frost on the coils of a freezer will decrease the efficiency from 15 to 25 per cent, according to the density and formation of the frost. It is quite easily removed with scrapers, if not allowed to become too heavy.

Do not use a hammer for cleaning coils, as the pipe is likely to split at the butted joints.

A. G. SOLOMON.

Stack Capacity

PLANS FOR a new power plant call for a 103-ft. stack 66 in. in diameter, with round vertical opening. The intention is to install 2 new 150-hp. boilers and use 2 old 6-in. tube cylindrical boilers of 120 hp. rating. Plant is used for power and heating, 300 hp. being the largest amount used at one time. Chain grate stokers are intended to be installed under 2 new boilers.

Two stoker salesmen have informed me that in order to get economy and efficiency a 150-ft. stack should be had. Architect says 103-ft. stack is sufficient. Kindly put me right.

In regard to new boilers, which will be the more economical as to coal consumed and upkeep, water tube or fire tube, with surface pond water and condensation from radiators for feed water, irregular load, stokers, and Webster vacuum system of heating? The installation is for economy, as first cost is provided for.

Will it be economical to use stokers (chain grate), with the load varying from 40 to 300 hp.?

How fine a soft coal can be burned successfully with 90 ft. stack (above floor), stack being at rear and side of boilers? There were 2 90-deg. bends in breeching before entering stack. Grates are stationary.

W. H. J.

A. If the new stack is to be direct-connected to the 2 new boilers, leaving the old stack to serve the old boilers, then the height of 103 ft. will be sufficient. In this case, the diameter of 66 in. will be larger than absolutely necessary. A stack 50 in. in diameter would answer.

If, on the other hand, the new stack is to serve all of the boilers, then it should have a diameter of 66 in., which will give it a ratio of 1:6 to total connected grate surface. In this case the stack should by all means be 150 ft. high. On stokers a minimum draft of 0.3 in. should be provided over the fire.

Ordinarily a more economical layout can be designed for water-tube boilers and chain grates than for horizontal return-tubular boilers; this, on account of the greater opportunity for flame travel and beneficial arrangement of arches on the water-tube boilers. In any event, with a load varying from 40 to 300 hp. there will be periods when no great economy can be realized with either type of boiler. A chain grate working at 40 hp. must necessarily be uneconomical.

With a 90-ft. stack and 2 90-deg. bends, you will get about 0.17 in. draft over the fire. This will burn 17 lb. of coal per sq. ft. of grate surface per hr., to advantage, which will be slightly under rating. You will have trouble in getting rating on the boilers if you burn coal of a size less than No. 3 washed, which is through a 1-in. and over a ¾-in. screen.

In regard to economy and up-keep of 2 types of boilers with feed water from a pond, condensation from radiators, etc., it is simply a question of how much mud will get to the boilers. If the water is muddy, the up-keep on the water-tube boilers will be lighter than with horizontal return-tubular boilers, while the economy also should be slightly higher.

O. M.

Character of Materials

WHAT IS semi-steel?

2. What is ferro-steel?

3. What is malleable iron?

4. What plates in a boiler are annealed?

5. With a battery of boilers containing 120,000 gal. of water, how much supplementary feed will be used in 24 hr.? All joints and stuffing boxes are supposed to be tight.

R. F. B.

A. Where high pressure and superheated steam is carried in pipe lines, a greater strength is required, especially so, in the valves and fittings. Manufacturers of these articles have brought out special materials, usually of a secret make or composition.

The Lunkenheimer Co., advertises its semi-steel as a high grade iron and steel alloy of very close grain and possessing greater tensional strength than cast iron. Its superiority over cast steel is in closeness of the grain and uniformity of the metal, a quality which is difficult to obtain in cast steel.

2. The Crane Co. manufactures its special material under the name of "Ferro Steel" and claims a tensile strength of 33,500 lb. per sq. in., or, as they claim, an increase of 80 per cent over the ordinary cast iron. The composition, likewise, is of secret formula and consists of an alloy of cast iron and steel.

3. Malleable iron is simply cast iron with the greater part of the carbon content removed. This gives it the quality possessed in wrought iron to a greater degree of being bent without breaking, and likewise having the ability to resist bumps or knocks without breaking as would ordinary cast iron. In short, malleable iron is cast iron with the good features of wrought iron included to a certain degree. Complicated forms as irregular castings, are first made of cast iron and the carbon is then removed in special furnaces.

4. All boiler plates which have had holes punched in them are required to be annealed as deterioration of the metal ensues through the punching process. The annealing is very often assumed, as effected through the heating to a cherry red heat preparatory to its being rolled to a circular form.

If the plates are drilled, the rolling can be done with the metal cold, provided the rolls are sufficiently strong for the operation.

5. Your question with regard to supplementary feed for boilers is not stated in full. The word supplementary may apply in any number of different installations. You would have losses in the safety valve blowoff, in boiler blowoff and in auxiliary steam requirements, if these were used for feed water heating. So you see, that with different combinations losses can exist in each different installation.

With a condensing plant under ordinary operation, we would say that about 10 per cent supplementary feed would be a good figure for additional water required.

F. W. B.

Softening Water Containing Oil

AT THE plant where I am employed we have been using water containing a large per cent of scale forming matter, and have had a great deal of trouble with scale in our boilers. We have the exhausts of nearly all engines and pumps piped into our supply tank, so that they carry in a great deal of oil. So far we have had no trouble with the oil in our boilers.

But, now, we have installed a water softener. The superintendent intends to leave all the exhausts run into the supply tank, claiming that as the oil has done no damage before it will do none now.

I contend that oil in soft water is far more dangerous to boilers than oil in hard water.

R. M. P.

A. We find that where there is a heavy precipitate of impurities in an open heater, or in a hot process softening system, all traces of oil, particularly emulsified oil, are removed from the water. In fact, the chemical processes ordinarily employed for the removal of oil from condensate consist in introducing reagents, such as alum and soda ash, which will produce a heavy precipitate in the water. The action of this precipitate, apparently, is to entangle or combine with the oil particles, and to carry them to the bottom of the settling chamber. There is possibly some electro-chemical action in this, as emulsified oil particles carry negative electrical charges, while many other ions, such as those of iron or aluminum hydrate, carry positive charges.

Your question, however, admits of another interpretation. If it is between perfectly softened, settled and filtered water, or hard, scale-forming water introduced into the boilers along with a certain amount of oily emulsion, we would expect to have more trouble from oil in the case of the softened water, since in that case the oil would form a sort of varnish on the plates and tubes, while with the hard water, it would be entangled in the sludge and largely disposed of through the blow-off. Cases have also arisen, we believe, where oil-saturated scale has proven a very serious menace.

Finally, we would say that a water softener is a very efficient device for removing emulsified oil from water, provided the emulsion is in the water before it enters the softening system, but we would not recommend mixing oily condensate with water, either hard or soft, after the water had left the feed water heater or softener and was about to enter the boiler.

In the above we have assumed all the way through that you refer to emulsified oil, since floating, or free, oil is efficiently disposed of by the skimming action of an open feed water heater. GEO. H. GIBSON.

Tandem Compound and Single-Cylinder Engines Compared

COMPARE A tandem compound steam engine with a single cylinder engine having the same length of stroke, running at the same speed, and developing the same power with the same boiler pressure and back pressure. What difference is there in severity of stress in the piston rod nearest the shaft? In the maximum pressure on the crosshead guide and on the crankpin? What are the advantages and disadvantages of a tandem compound engine as compared with a cross compound engine? G. C. W.

A. Having 2 engines, a simple, and a tandem compound, both operating at the same speed, having the same stroke, developing the same power, it is desired to compare them as to stress in the piston rod nearest the shaft, and also on the crosshead guide and on the crankpin.

With the assistance of the chemist, modern engine builders are enabled to design the several parts so as to determine within a very small margin, the stresses on the pins, slides and bearings.

We will assume that the 2 engines are to develop 1000 i.hp., 1 to be simple, and the other to be tandem compound. The designer calculates the stresses on the several parts, such as the pins, slides, bearings, etc., knowing that in 1 instance, 1000 i.hp. is to be developed in a single cylinder and in the other, in 2 compound cylinders arranged tandem, so that the combined impulse of both of them will act at the same time on the pins, slides, and bearings in unison.

Thus in each instance, it is possible to calculate the maximum strains on all of the parts, and to make the pins of the tandem engine enough larger so as to have the same pressure per square inch of area as the pins of the simple engine. The same is done with the piston rods, that of the tandem engine being larger so as to provide for a greater stress, which is liable to happen under a considerable range of receiver pressures.

For instance, the simple engine has a rating, as has been said, of 1000 i.hp. at economical load with a long range cutoff. This would provide for perhaps 1600 to 1700 i.hp. maximum to take care of a peak load such as present day engines are sometimes called upon to handle.

Tandem compound engines designed for very severe work, such as is common in rolling mills, to take care of 1000 i.hp. at most economical rating, but are frequently arranged in such a manner as to admit live steam at boiler pressure to the low pressure cylinder. The piston rod, and pins must be designed to take care of this excess load.

As for the slides, in order to reduce the cost of pattern and foundry work as much as possible, frames (for horizontal engines, especially) are made in about 6 or 7 sizes, and each size will take cylinders ranging over several inches difference in diameter. A certain sized frame may accommodate cylinders all the way from 16 to 22 in. in diameter. The size of the slide will be designed so as to be ample for the engine with the larger sized cylinder.

A tandem compound engine has these advantages over a cross compound: Lower first cost, fewer parts, less floor space, making it possible to install such an engine where building foundations would preclude any other type. Generally, there is also less condensation between the 2 cylinders, as the receiver and piping is more direct.

Its disadvantages are that it has but 2 impulses per revolution, while a cross-compound almost invariably has the cranks set at 90 deg., and thus has 4 impulses per revolution.

This disadvantage produces a more uneven turning moment, especially at slow speeds, which is very noticeable, especially in engines direct-connected to generators. It is considerable of a task to make repairs to the low pressure cylinder next to the frame, or even to inspect the cylinder, as frequently as should be done, owing to the difficulty of removing the distance piece and gaining access to the interior of the low pressure cylinder.

It is not possible to secure the fine adjustment of the valves in a tandem, as a usual thing, that can be done in a cross compound, as there are not separate eccentrics for each cylinder.

In addition to the above, there are both advantages and disadvantages due to local conditions, that it is not possible to enumerate here. Conditions must govern such instances. However, it might be added that a tandem compound engine is slightly less economical than a cross compound. G. H. WALLACE.

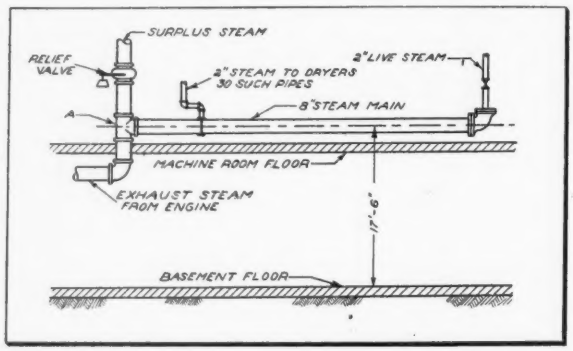
THE SOUTHERN POWER CO., which is under the control of the Duke interests, will shortly begin the construction of a hydro-electric power plant at Lookout Shoals on the Catawba River, near Stansville, N. C. Contracts for the work have already been awarded and call for the construction of a power house and dam sufficient to develop 26,400 hp. The work is to be completed by Oct. 1. The plant, together with the building of 5 mi. of railways, will cost about $1,000,000. It will give the Southern Power Co. an aggregate of 154,000 hp. for distribution. The company already has under way developments at 4 other hydro-electric plants, totaling 98,000 hp.

Problems For Discussion By Readers

What Would You Do If You Had These Conditions To Meet?

Drain for Steam Pipe

THE ACCOMPANYING sketch represents the steam piping to the dryers of a paper machine in a certain mill. The machine has 30 dryers, each one of which is supplied with steam by a 2-in. line, saddled to an 8-in. steam main. The steam used is exhaust from the engine which drives the machine. Point A (see sketch) is about 120 ft. from the engine. The line is not covered and the condensation high. As may be seen from the drawing, the line is not dripped at any point and all water



SECTION OF PIPING IT IS DESIRED TO DRAIN

of condensation must enter the dryers in order to escape. Regardless of the fact that the drying capacity of the machine is being decreased, because of this, the company is not willing to purchase steam traps. Can any of the readers suggest a method of draining this 8-in. main without the use of traps? Pressure varies from 7 to 15 lb. and occasionally reaches 20, but this is very seldom. I believe a drain pipe in the form of a V could be used, but have never seen it tried and would like suggestions.

H. H. S.

Questions From a Massachusetts Examination

IF YOU found water coming back to your engine, through your exhaust pipe, what would you think was the matter?

2. If you had a riding cutoff that was cutting off steam at ⅝ stroke, which is considered to be cutting off very early, what would you do to have it cut off at ⅜ stroke?

3. If you were running a third-class plant and had an engine that is supposed to run 100 r.p.m., but the plant was getting large as time went on and your engine got overloaded and you found you were running only 90 r.p.m., what would you do to have your engine run up to speed without changing your boiler pressure?

4. What without changing your governor?

5. If, on your engine, you had a piston valve with piston rings, and one of them broke, what would you do to replace it?

6. Suppose they sent you a whole ring, how would you put it in?

7. Suppose they sent you an eccentric ring, whole, how would you fix that?

8. How would oil and grease affect a Manning boiler?

9. If you were in charge of a horizontal boiler that was being installed, and the brick mason wasn't an up-to-date man, how would you know if your boiler was on the right pitch?

10. What is the principal feature of a flush-front boiler?

11. Where are fire cracks apt to be found on a horizontal return-tubular boiler?

12. If you shim the boxes of a gib and key type connecting rod, and the boxes came up tight together, would it be proper to run them that way?

13. How could they be fixed?

14. How are the hand-hole plates put together on a B. & W. boiler?

15. How would you know whether the check valve was leaking on gravity return heating?

16. Can you run without a check valve?

Heating Problem

IN ANSWER to A. L.'s query, Heating Surface Required, on page 175 of Jan. 15 issue, I submit the following:

Total exposure is $(110 + 130) \times 2 \times 11.5 = 5520$ sq. ft.

Glass surface, $14 \times 8 \times 24 = 2688$ sq. ft.

Net wall surface is $5520 - 2688 = 2832$ sq. ft.

Assuming the wall to be 20 in. thick, and of fair construction, we have $2832 \times 18 = 50{,}976$ B.t.u., loss through wall per hour. Loss through windows is $2688 \times 93 = 249{,}984$ B.t.u. per hr. Combined losses $= 50{,}976 + 249{,}984 = 300{,}960$ B.t.u. per hr. Adding 16 per cent for total exposure, 10 per cent for ceiling, and 20 per cent for leakage, we have $300{,}960 \times 1.16 \times 1.10 \times 1.20 = 460{,}469$ B.t.u., the total losses per hour.

Temperature difference between steam and the air of the room is $240 - 80 = 160$ deg. F.

Radiation in B.t.u. per hr. per sq. ft. of pipe is $160 \times 2 = 320$ B.t.u.

Square feet of pipe required $= 460{,}469 \div 320 = 1439$ sq. ft.

Linear feet of 1½-in. pipe $= 1439 \times 2 = 2878$ ft.

Linear feet of 2-in. pipe $= 1439 \times 1.6 = 2302$ ft.

Since the length of the supply pipe is not given, we will assume it to be 100 ft., and be on the safe side. A pipe 100 ft. long and 2 in. in diameter, with 60 lb. initial gage pressure and ½ lb. drop, will supply 8.8 lb. of steam per minute, and with 5 lb. drop, 27.86 lb. per min.

The steam in pounds per minute needed for our problem, is $460{,}469 \div 898.8 \times 60 = 8.53$. Therefore, the 2-in. pipe is big enough.

The main supplying the radiators from the reducing valve should be 4 in. in diameter. STEPHEN DAVIS.

IN ANSWER to A. L., about heating surface required. In figuring the amount of heating surface required, I use the following rule: Divide the difference between the temperature at which the room is to be kept, and that of the coldest outside atmosphere, by the difference between the temperature of the steam pipes and that at which you wish to keep the room, and the quotient will be the square feet, or fraction thereof, of plate or pipe surface to each square foot of glass, or its equivalent in wall surface. Ten sq. ft. of wall surface, if well built, are equivalent to 1 sq. ft. of glass. The combined area of the walls is $(110 + 130) \times 11.5 \times 2 = 5520$ sq. ft. The area of glass surface in the windows is $14 \times 8 \times 24 = 2688$ sq. ft. $5520 - 2688 = 2832$ sq. ft. of wall surface. $2832 \div 10 = 283.2$, equivalent glass surface. The total equivalent to glass surface $= 2688 + 283.2 = 2971.2$ sq. ft.

Steam at 10-lb. pressure has a temperature of 240 deg. F. Then, heating surface in square feet $= \frac{80}{240-80} \times 2971.2 = 1485.6$. For air leakage and roof add 25 per cent, and when the building is poorly built and exposed on all sides to very cold winds, add 50 per cent. Adding 25 per cent, we have $1485.6 + 371.4 = 1857$ sq. ft. of radiation required to keep the building at 80 deg. with an outside temperature of 0. The amount of 1½-in. pipe required will be $1857 \div .494 = 3760$ linear ft., nearly. The amount of 2-in. pipe required will be $1857 \div .622 = 3000$ linear ft., nearly. The 2-in. pipe from the boilers is large enough, but I would advise to run the outlet from the reducing valve into a 3½-in. pipe.

JAS. BROWER.

Boiler Patches

IN REGARD to F. E. K.'s question about the difference between soft and hard patches, I would say that a hard patch is put on inside a boiler where a piece of the boiler plate is cut out, as in a fire sheet where a bag is cut out, and riveted fast and calked. The patch is made to the same shape as the plate it is to cover.

A soft patch is put on outside of the boiler to cover cracks, and no metal is cut out. It is bolted fast to the boiler with red lead between. The hard patch is the stronger, and inspectors will invariably cut down the allowable pressure on boilers having a soft patch.

A hard patch can be put on a plain fire sheet, a stayed fire sheet and across a girth seam.

The patch should have the same thickness as the sheet, plate to be beveled off where it crosses a seam to prevent burning of rivets. C. M.

A SOFT patch is one that is put on with bolts and nuts or with tap bolts. Red lead putty is used between the plates to make a water tight joint under pressure. Soft patches at best are only makeshifts and should not be used at all on plates that are subjected to the direct heat of the fire.

Hard patches are secured with rivets and should be the only kind of patches used on boiler work.

In putting hard patches on plates that are directly over the fire, the weak or otherwise affected part of the plate should be cut out before the patch is placed on.

The patch, whether hard or soft, should be placed on the inside, that is, on the water side of the plate. This is done for the same reason that manhole and handhole plates are placed on the inside instead of on the outside of the boiler.

Plates that are badly blistered or otherwise injured should be cut out and replaced with new plates.

C. J. BRICKER.

Diagram for Criticism

I AM enclosing an indicator diagram upon which I would like to have some of the readers of Practical Engineer express an opinion.

They are taken from a 16 by 42-in., single eccentric, Corliss engine, running at 84 r.p.m., 100-lb. steam pressure.

Owing to having nothing less than a 60-lb. spring, we couldn't take it as it probably should be taken.

This engine is about 12 yr. old.

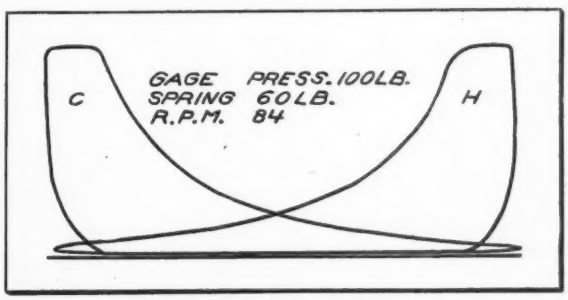


DIAGRAM FROM CORLISS ENGINE

With the governor safety in, both dashpots down solid, and the hooks not engaging, and with the wristplate hooked up so as to work the exhaust valves properly, the engine will make a speed of 24 r.p.m. with the throttle wide open.

With the engine on either quarter, it will start by leaving the wristplate hooked up and lowering the dashpot, which should be up.

I would like to have some reader tell why it doesn't show on the card. R. B.

ONE HUNDRED NINETY-ONE CONVENTIONS, which will be attended by delegates from all parts of the world, have voted to hold their sessions in San Francisco in 1915. The organizations are varied in character and include civic, religious, social service, educational, fraternal, business, labor, commercial, agricultural, live stock and scores of other interests.

PRACTICAL
ENGINEER
Trade-mark reg. U. S. Pat. Office.

PUBLISHED ON THE FIRST AND FIFTEENTH OF EACH MONTH
At 537 So. Dearborn Street, Chicago, Ill., by the
TECHNICAL PUBLISHING CO.
New York, 150 Nassau St. Cleveland, Am. Trust Bldg.

Notify us at once of any change of address, giving the old and the new address, so that your paper may always reach you promptly.

Copyrighted, 1914, by Technical Publishing Co.
Entered as second class matter May 1, 1908, at the Post Office at Chicago, Illinois, under the Act of March 3, 1879.

Circulation of this issue, 23,500.

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What Constitutes a Chief Engineer?

There is hardly an engineer today who is not ambitious to climb to a little higher plane in the engineering profession than that which he now occupies. Some realize that they have reached the limit of their ability where they now are in a small plant, where all of the routine work is performed by one man.

But to the great majority, and especially among the younger engineers, the height of their ideal is to rise to the coveted position of Chief Engineer, and it is indeed gratifying to know that so many of the coming generation have established so high an ideal.

The late Pres. Cassett, of the Pennsylvania System, said that if he knew of any man in his employ who did not aspire to the high office of president of the road, he would order that he be discharged.

What, then, constitutes a Chief Engineer? Perhaps all our readers know of a number of persons who occupy this high position in their community and will at once gage the position by the caliber of these men, and were several engineers from different communities to gather and compare answers to the above problem, no doubt the answers would differ considerably.

The last 20 yr., and especially the last decade, has thrust forward an enormous quantity of more or less intricate and complicated devices that have to do with modern power, its generation and transmission. Where a power house record was made only by a consulting engineer, or technical professor, who was called in to look the plant over, or plan additions, today many engineers, even in small plants, keep accurate records as to operating conditions.

Thus it is that the man in charge of the production of power in these times must be a steam engineer, an electrician, a refrigeration expert, and have a thorough knowledge of high-pressure air, water and superheated steam, combustion and kindred subjects.

Then there is added to the duties of the chief engineer, the ability to build up an organization out of his force, that will work industriously and harmoniously for the ultimate success of the plant and the firm.

This requires tact, executive ability, and a knack of "handling men," as it is frequently called, and while many men possess technical and mechanical qualifications, necessary to become a chief engineer, those who combine with this the fine art of handling the men are unfortunately rare, and men of this caliber are being sought continually, and the supply is meager when compared with the demand.

Diplomacy is as much a part of a modern chief engineer's stock in trade as is a thorough knowledge of advanced mathematics, and fortunate indeed is the chief whom the subordinates speak of as "the best man there is in the business."

While the mechanical problems that the chief must solve in the course of a given time are many and varied, they are no less important than that of studying the disposition and ability of each man in his department and how best to increase his earning capacity without increasing his actual manual labor.

A grievous fault of some chiefs is that they consider the men as but parts of an inanimate machine, incapable of having finer sensibilities, and who must con-

tinually be the victim of his irritable disposition, and harsh words. An "I am loftier than thou" position will soon undermine the good intent of the best man on the payroll.

While the chief engineer should be familiar with the equipment in his charge, and be able to advise in cases of repairs, etc., it does not necessarily mean that he should be the only one who has knowledge of each machine. Give each man credit for being intelligent in his own line, and capable of holding up his end, but make each feel that he must do his best, and that in case of necessity he can be at perfect liberty to go to his chief without restraint, and discuss the matter fully and freely.

Do not belittle a man. If he is good enough to be an employe, he is good enough to be encouraged. It is a grave mistake not to show the men about the equipment or to explain its intricacies to them. It soon creates a listlessness that cannot be overcome. As an instance, whenever a certain chief engineer applied the indicator, he always sent the assistant out of the room, or away upon some inconsequential errand. The same thing was done when adjusting valves. This is poor practice. A few minutes' explanation in either of these cases would have created a new interest in the assistant and have given him food for thought, which would not only have made him a better and more satisfied man, but a brighter man in that particular position.

Sometimes a chief believes erroneously, if a subordinate be instructed in these small details, that his position as chief will be jeopardized to the advantage of the assistant. This is narrow and at once stamps a man as lacking many of the essentials of a good chief.

One sometimes encounters (and more frequently than he ought) a chief who lacks definiteness, especially when it comes to details. It creates a bad impression among the men when, for instance, a certain pipe connection is put up, only to be torn out at once and put up some other way. How soon the men will say, "He doesn't know what he wants."

A chief should have an abundance of foresight, and if he is lacking in this respect, he should cultivate the habit of looking into the future, not only as to time, but also as to mechanical conditions. Frequently when plans are prepared for a certain extension, some small but really important detail is omitted either accidentally, or on the belief that it can be worked out as the work progresses.

And just as sure as this occurs, one will find that machinery (principally auxiliaries) will interfere with beams, electric cables, belts, or with existing pipe lines, and when the difficulty is at last settled the job has become a botch.

Too much attention cannot be given to details, especially where steel and concrete construction are a part of the principal plan. Just because a cable is more or less flexible, is no reason why it should be twisted in and out, and over and under pipes and girders, when a little intelligent thought in the first place would have prepared a place for it with considerable saving in time and material.

A volume might be written on handling firemen, alone. All too frequently a man is hired as a fireman because he says he is one and not because the chief determines by examination and observation that he is what he claims. There are little differences in all boilers and the method of handling them successfully, and the chief should be able to doff his coat and collar and instruct the man just what to do and what not to do, and show the results which follow.

A chief who can do this will make a friendly employe who will be a valuable asset, for it is but human nature to frown upon a man who says, "Do thus and so," in preference to, "Let me *show you* how this should be done."

There are technical works in abundance on all of the many subjects that the chief engineer has to deal with every day, and these can be consulted from time to time as required, but there are no books that will teach one how to handle men. This is something that must be studied right on the job, by the chief himself, for there are no 2 men that require the same treatment to secure the same results.

No matter how skilled in mechanics, or how well versed in theory and practice one may be, unless he can handle men, and obtain results while still retaining their admiration and good-will, he is lacking in one of the prime requisites that go to make up a successful chief engineer.

Design Registration

In the past there has been difficulty with the registration of designs, either decorative or of standard forms of machinery and apparatus, because such a design, to be patentable, must have the element of invention in it; that is, it must be something new, not used before. Under such a law, it is extremely difficult to protect any design, as almost any decorative pattern will embody features previously used, and any new design of machine, while it may be for a different purpose or of a new size and line, cannot have its form patented if it is of a form that has been used before. This makes it impossible to protect the particular shape of any apparatus as a distinctive trademark, even though it may be an essential part of the design and a valuable feature.

To overcome these effects, the Oldfield Design Registration Bill has been introduced, which proposes to recognize a copyright ownership in designs, and make unlawful the copying of these designs for like articles of manufacture. This registration is issued promptly and at nominal fee. Registration of a particular design does not imply that it is new and original in itself, but that its application to that particular kind of a machine or purpose is new. Conflict of interests with regard to registration is left to be settled afterward by court proceedings. The fees proposed are $1 for a 3-year term, $10 for a 10-year term, and $30 for a 20-year term. It is a constructive piece of legislation, designed to help out the protection of rights of inventors and designers in manufactured products, and is worthy of general support and of calling to the favorable attention of Members of Congress.

AMONG "NEWEST notes of science," an esteemed daily avers that a recording meter has been invented to measure the amount of steam used in an industrial plant in order to check waste. Glad to know they've heard of it at last.

Power Apparatus in Shop and Market

New Ideas In Making, Buying and Selling

Direct-Connected Generating Sets

COMPACT GENERATING UNITS OPERATE EFFICIENTLY AND REQUIRE LITTLE ATTENTION AND REPAIRS

FIGURE 1 represents a sectional view of a simple and compact design of generating set, consisting of a vertical engine driving a direct-current generator. All working parts of the engine are readily accessible, and easily adjusted by means of the removable side doors and handhole plates on the sides of the engine frame.

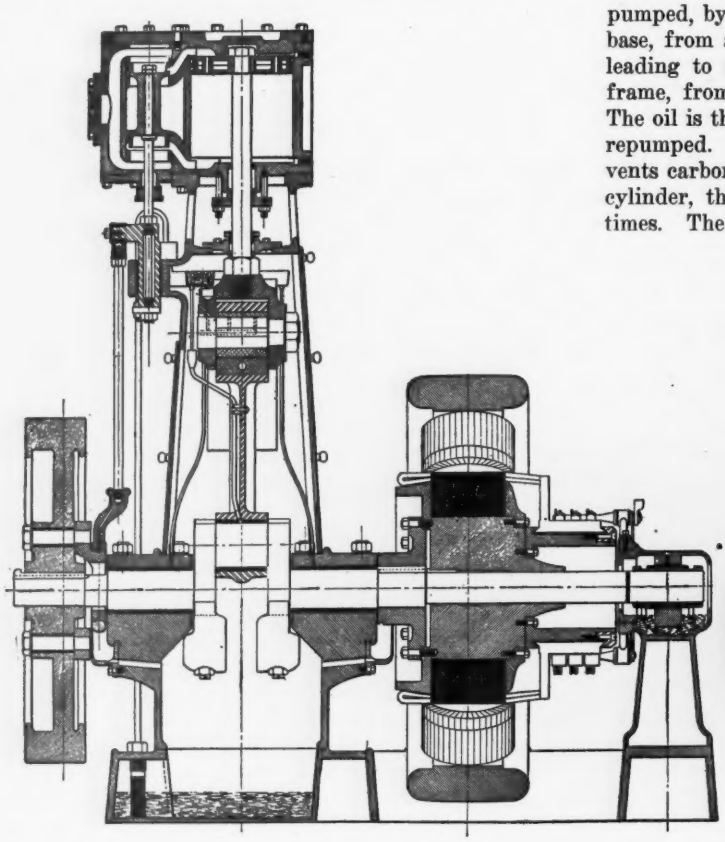

FIG. 1. SECTIONAL ELEVATION SHOWING CONSTRUCTION OF DIRECT-CURRENT GENERATING SET

Balanced piston valves are used, and on sizes larger than 2½ kw., the valve chambers are fitted with removable bushings. The piston is cast hollow for lightness, and is placed on the piston rod with the nut on top and riveted on. The crosshead, which is of heavy construction, is fitted with a phosphor bronze shoe with wedge adjustment, and a tapered pin of hardened and ground steel. The connecting rod is provided with a wide, babbited bearing at the crank end, while the upper end is fitted with bronze boxes, provided with a standard wedge adjustment. The main bearings are provided with babbited split bushings that can be renewed by slightly raising the crankshaft, which, on sizes larger than 5 kw., is fitted with counter-balances.

Speed is controlled within 2 per cent from no load to full load by means of a special design of flywheel governor of the centrifugal type.

On sizes larger than 2½ kw., lubricating oil is pumped, by means of an oil pump located in the engine base, from an oil reservoir up into a sight-feed oil cup leading to a distributing oil trough inside the engine frame, from which pipes lead to all movable bearings. The oil is then drained back into the base, refiltered and repumped. A water-shed partition in the frame prevents carbonizing of the oil, due to contact with the hot cylinder, thus leaving clean oil in the reservoir at all times. The 2½-kw. generating set receives lubrication

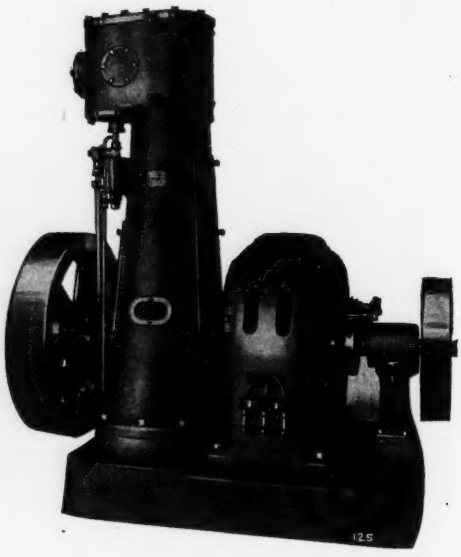

FIG. 3. ALTERNATOR SET COMPLETE

from a conveniently located sight-feed multiple oiler, the outboard bearing, which is a bronze sleeve and self-alining, being lubricated by oil rings.

Direct-current generators are of the multipolar type, and, unless otherwise specified, are compound wound

for 115 v., the shunt and series coils being separate and form wound. The armature is of the iron-clad, ventilated type, with laminated core, the drum and core being provided with air ducts which permit a thorough circulation of air. The commutator, which is of heavy construction, is built up on a separate sleeve and bolted to the armature drum, to which the engine crank is coupled direct, permitting removal of the shaft without disturbing the windings. In Fig. 2 is shown a complete unit as built in sizes of from 6 to 15 kw.

Alternators will operate continuously at full kv.a. rating and will carry a continuous overload of 20 per cent, with a lower temperature rise than the standard established by the A. I. E. E. Momentary overloads of 60 per cent may be carried without injury. Standard voltages are 240, 480, 600, 1200 and 2400, but other voltages can be supplied. Figure 3 illustrates an alternator set.

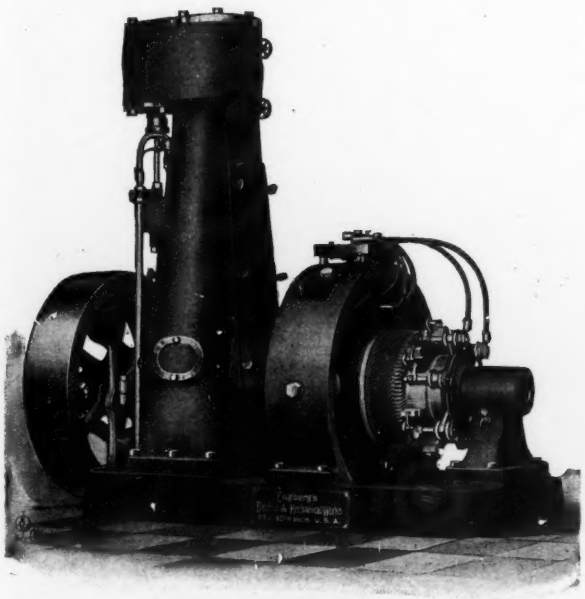

FIG. 2. DIRECT-CURRENT UNIT INSTALLED

For a given size of alternator, all armature coils are of the same shape, so as to be interchangeable. The alternator teeth are carried by simple but effective steel supports, which are open to allow the free passage of cooling air and are positively locked in position in order that they may not work loose and cause trouble.

In this machine the construction is such as to secure effective ventilation. The back of the core is practically open to the air and free to radiate to the air set in motion by the revolving field. The open-tooth supports at each end, form ventilating spaces next to the armature core, where most of the heat is generated, and the core is also cooled by other ventilating spaces in the body, thus maintaining all parts of the machine at a nearly uniform temperature.

All pole pieces consist of soft, laminated sheet steel punchings assembled with rivets so that the complete revolving field, Fig. 4, is built up of duplicate pole pieces equally spaced. The field coils are of square, copper wire wound on forms, or copper ribbon wound edgewise, making all coils exact duplicates. A uniform temperature is maintained by means of an air duct at the end between the field coil and pole piece.

Direct-current sets range in size from 2½ kw. to 50 kw., and the standard line of alternating-current sets consists of sizes up to 70-kv.a. capacity in several different speeds. In addition to the above direct-connected machines, belted generating sets are also furnished.

All generating sets are carefully tested before shipment, and the rating, stability and performance are guaranteed by the manufacturers, Engberg's Electric & Mechanical Works, St. Joseph, Mich.

IN AN EDITORIAL in its issue of Feb. 2, the Tribune Republican, of Scranton, Pa., pays a high tribute to the work of the International Correspondence Schools, which it calls the "Universal University." It calls attention to some statistics as follows: One thousand seven hundred and fifty-eight men and women are employed in the schools in writing and revising text books, correcting instruction papers, answering letters, and advising students. Scattered about the United States and Canada are some 17,000 more, who are encouraging students to take up the work, and who, in 1913, enrolled nearly

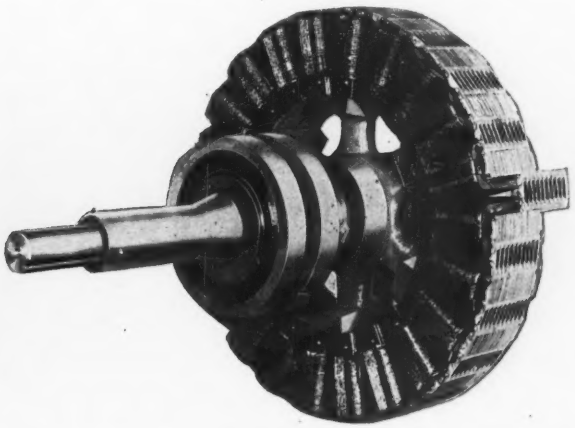

FIG. 4. ILLUSTRATION OF REVOLVING FIELD WITH SHAFT

100,000 new students in the schools. This makes a total enrollment with those previously on the books of 1,651,765, during the last 20 yr. In 1913 1,066,203 instruction papers were corrected and returned to students and 205,813 special and individual letters were sent to those who were having peculiar difficulties. Also, to encourage those who were lax in their work or who were not keeping up with the course, 805,079 letters were sent out, such letters as during the past 4 yr. have secured 55 per cent more study than was possible previous to that time among the students. Truly, the schools are not without honor in their own country, and Scranton has reason to be proud of them.

AT BARTLETT, TEX., W. V. Irvin, proprietor of the Bartlett electric light plant, has purchased 2 brick buildings on Clark St. and is having them put in shape for the light plant. New machinery will be installed and a stock of fixtures will be carried, giving Bartlett one of the best plants in the State.

Automatic Check and Float Tank Valve

A Single Valve Performs the Function of Both a Float and a Check Valve

THIS valve is intended for installation in the bottom of the tank, only one pipe being used for both the inlet and the discharge, as shown in Fig. 1. Water is maintained at any desired level in the tank by means of a float connected to a weighted lever, which bears down on top of the valve stem. When the water level is below normal, the weighted lever arm holds the valve open against the action of the helical spring, permitting water to enter the tank through a circular opening around the valve stem. The valve is held open until the water reaches the normal level, at which point the float lifts the weighted lever off the valve stem, permitting the valve to be closed by the action of the spring, as there is no connection between the lever arm and the valve stem. As soon as the valve closes, a back pressure is built up in the pipe line and is carried to the top of the pump governor, whose action stops the pump.

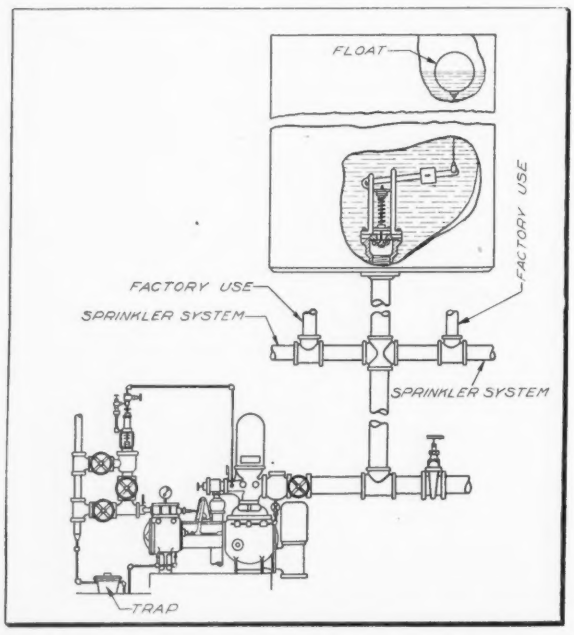

FIG. 1. SKETCH ILLUSTRATING VALVE INSTALLED IN TANK AND PIPING ARRANGEMENT TO PUMP

From its construction, as shown in Fig. 2, it will be noted that the valve acts similarly to a pop safety valve, seating slowly so as not to bring the pump to a sudden stop. While the tank is full, fire pressure can be carried on the sprinkler system or other mains, without danger of overflowing the tank, for the harder the pressure against the valve, the tighter it seats. As soon as water is taken from the pipe leading to the tank and the pressure reduced, the weight of water in the tank presses down on the valve and holds it off its seat, allowing water to flow from the tank through the same pipe through which it entered. Then the pump starts and assists the tank in supplying the quantity of water needed, continuing to work as long as water is being used, and until the tank is filled to the normal level.

This valve, which combines in one valve all the features of a float and check valve, has been thoroughly tested and found positive in its action. It is manufactured by the Fisher Governor Co., of Marshalltown, Iowa.

In the farm tractor field, a departure has been made in the design of the Joliet oil tractor, which has a 3-point suspension with spring mounting on both the front and rear axles, thus permitting of high speed over ordinary roads. It has 3 speeds forward and one reverse, can run up to 8 miles an hour on high, and down to 3½ miles an hour on low, thus making it available for hauling heavy loads or for comparatively rapid travel in returning light. The engine is a 4-cylinder, heavy

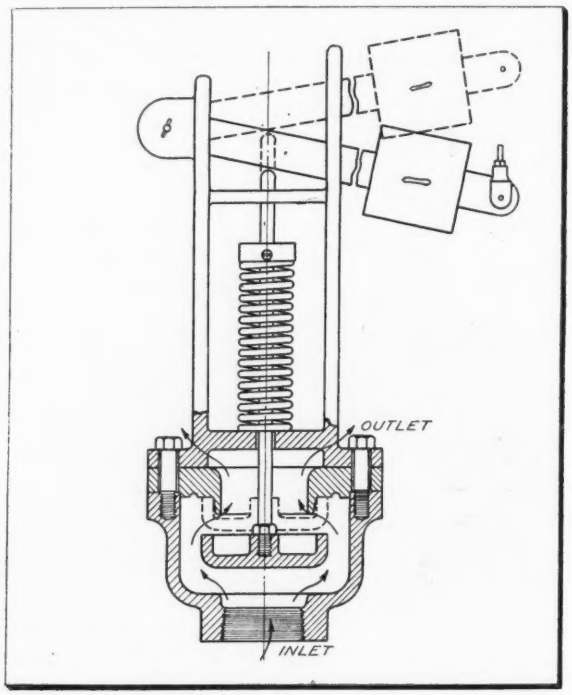

FIG. 2. SECTIONAL VIEW OF VALVE

duty, kerosene-burning type, with roller bearings and driving through a roller chain. The machine is of light construction, of strong material, giving a weight of 8700 lb., but with friction reduced so that one man can roll the machine along the floor with one hand. Three-point suspension is provided to overcome road inequalities, and capacity is furnished sufficient to pull from 4 to 8 plows, depending on the nature and depth of soil to be turned. The engine is rated at 40 brake horsepower, and will give 22 hp. at the drawbar at 600 r.p.m., the maximum speed being 900 r.p.m. This speed is regulated by a flyball type of governor, which can easily be adjusted to give anything from 200 up to 1000 r.p.m. The engine is water cooled, with a radiator of cellular type, having capacity of water to last from 10 to 12 hr., under full load. Control and levers are arranged so that one man can operate both the engine and the plows or other tools which may be drawn by the tractor. This new design is made by the Joliet Oil Tractor Co., of Joliet, Ill.

These tables contain data especially worked out or carefully selected that are vital to your work. You

These tables contain data especially worked out or carefully selected that are vital to your work. You may need them at any time and should preserve them. A handy, serviceable, loose-leaf cover in which these tables fit exactly, will be sent you for 30 cents in currency or stamps.

PRACTICAL ENGINEER

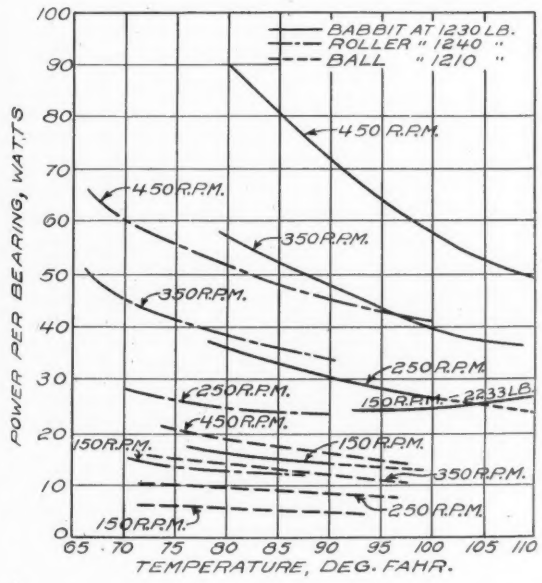

FIG. 2. POWER-TEMPERATURE CURVES FOR VARIOUS SPEEDS

PRACTICAL ENGINEER

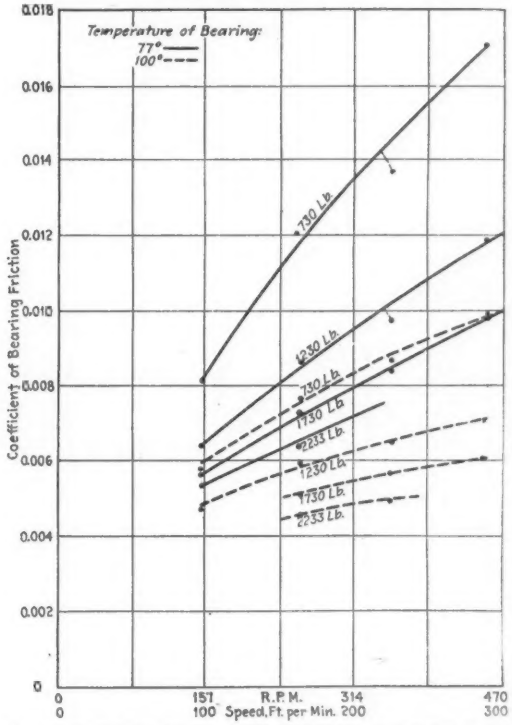

FIG. 4. BABBIT BEARINGS. COEFFICIENT OF FRICTION-SPEED CURVES FOR VARIOUS LOADS PER BEARING

PRACTICAL ENGINEER

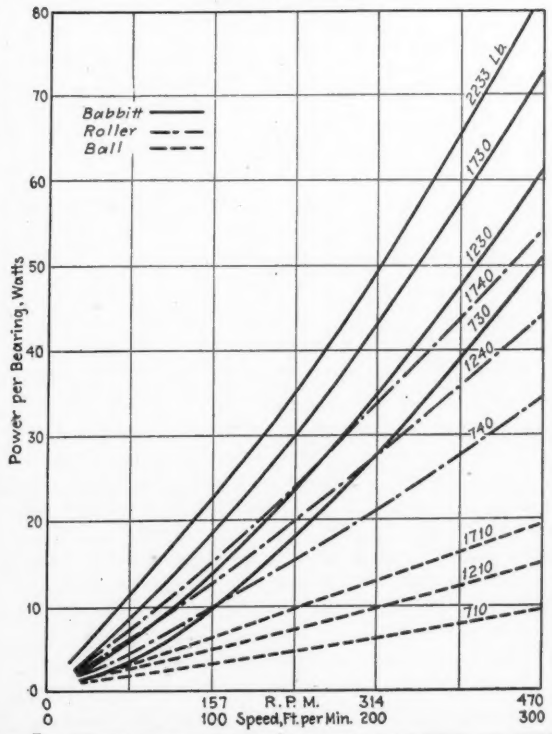

FIG. 7. COMPARISON OF THE POWERS CONSUMED BY FRICTION IN BEARINGS, AT LOADS PER BEARING AS INDICATED; TEMPERATURE, 100 DEG. F.

PRACTICAL ENGINEER

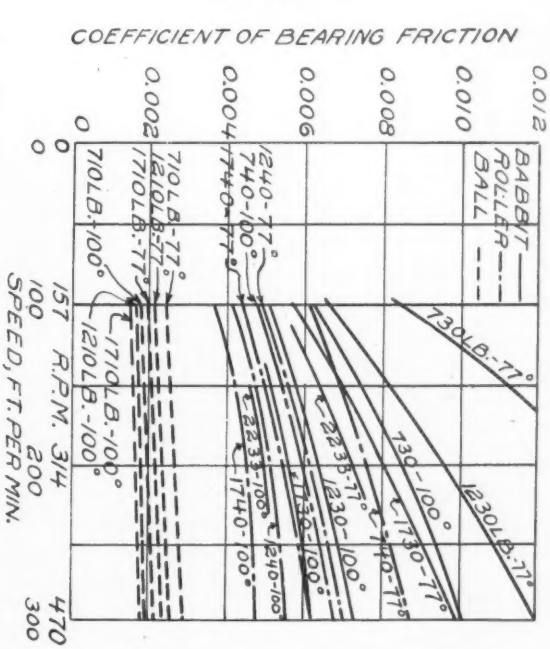

FIG. 9. COMPARISON OF COEFFICIENTS OF FRICTION FOR BABBIT, ROLLER AND BALL BEARINGS AT LOADS PER BEARING AND TEMPERATURES AS INDICATED AND VARIOUS SPEEDS

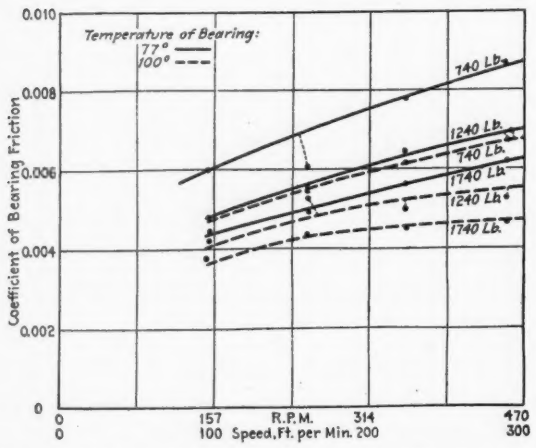

FIG. 5. ROLLER BEARINGS. COEFFICIENT OF FRICTION-SPEED CURVES FOR VARIOUS LOADS PER BEARING

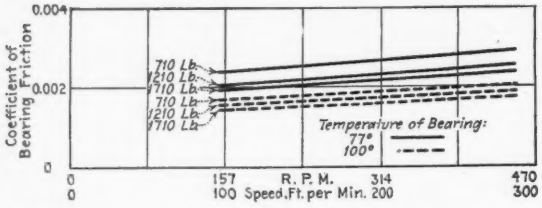

FIG. 6. BALL BEARINGS. COEFFICIENT OF FRICTION-SPEED CURVES FOR VARIOUS LOADS PER BEARING

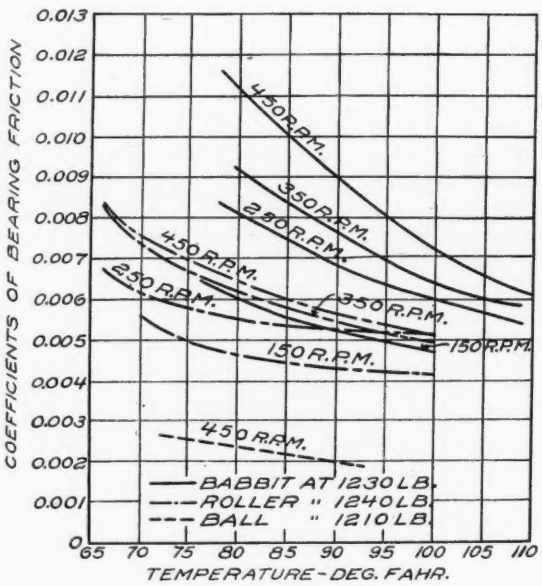

FIG. 3. COEFFICIENT OF FRICTION-TEMPERATURE CURVES FOR VARIOUS SPEEDS

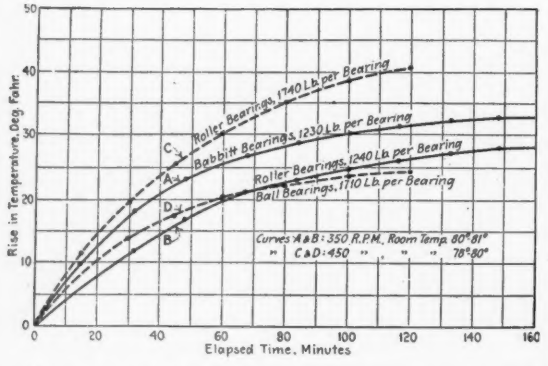

FIG. 10. RISE IN TEMPERATURE. DIFFERENT KINDS OF BEARINGS UNDER PRACTICALLY IDENTICAL CONDITIONS

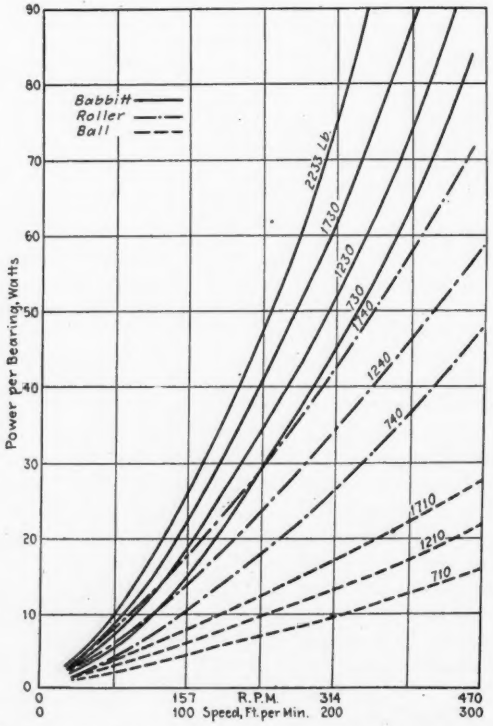

FIG. 8. COMPARISON OF POWERS CONSUMED BY FRICTION IN BABBIT, ROLLER AND BALL BEARINGS AT LOADS PER BEARING AS INDICATED AND VARIOUS SPEEDS; TEMPERATURE OF BEARING, 77 DEG. F.

News Notes

THE NECESSITY for larger space and better facilities to handle their increased business compelled the Indianapolis, Ind., and Louisville, Ky., branches of the H. W. Johns-Manville Co. to seek larger quarters. The new address of the Indianapolis branch is 408-410 North Capitol Ave., that of the Louisville branch, 659-661 S. Fourth Ave. Both of these branches will include ample warehouse accommodations, in addition to show rooms for the display and sale of this firm's varied line of asbestos roofing, pipe coverings, insulating materials, lighting fixtures, automobile accessories, etc.

THE TRUSTEES of the Tuskegee Normal and Industrial Institute at Tuskegee, Ala., held their annual midwinter meeting at the school recently, and authorized acceptance in full of plans for a new power house, new water distribution system, including fire protection, new steam piping, new sewerage and sewage disposal systems, new electrical equipment, and electric service system, the whole to cost $240,000 or thereabouts. Plans also are to be drawn for the installation of an ice plant and cold storage system.

SIMULTANEOUSLY WITH THE ANNOUNCEMENT that A. Welsh, builder of the first unit of the Portland, Eugene & Eastern Railroad, has purchased the Yaquina Electric Co.'s plant at Newport, Ore., comes the information that he has secured water rights on the Siletz River in Lincoln County. It is understood Welsh intends to begin the construction of the first unit of a $150,000 hydroelectric plant to supply Newport and surrounding country with electricity and power. The first unit will be built to develop 2500 hp.

IT IS STATED THAT the Lebanon Valley Light and Power Co., better known as the Weaver interests, has commissioned H. W. Hamblin, a Harrisburg, Pa., architect, to prepare plans for the construction of a central power plant at a point midway between Reading and Annville, 5 mi. west, to supply electric current to the entire county. Two 500-kw. turbine engines and sufficient equipment to give lighting facilities to the entire county are contemplated in the installation of generating machinery.

AT A SURPRISE DINNER given at the Hotel Bond, Hartford, Conn., on Saturday evening, Feb. 14, Edwin Loomis King, receiver for the Pratt & Cady Co., was the recipient of a loving cup, presented to him by the employes of the Pratt & Cady Co., as an expression of their appreciation of his good work during the past 18 months in the management of the company's affairs, and to commemorate the second anniversary of his connection with the establishment.

The evening was one of general rejoicing at the successful adjustment of the company's difficulties. This spirit of rejoicing was also due in part to the fact that it is expected the business will be taken over by Bishop White, of West Hartford, within the next few days, and that Mr. King will still remain with his old associates in another capacity than that of receiver.

THE C. & C. ELECTRIC & MFG. CO., of Garwood, N. J., announces that the Indianapolis territory will temporarily be taken care of by its Cincinnati representative, F. A. Saylor, 6th and Vine Sts., Cincinnati, Ohio.

AT SAN ANGELO, TEXAS, J. D. Sugg is having plans prepared for the erection of a large street car power house. This is a part of the plan he has in view for improving the San Angelo Street Railway Co.'s system.

PROFESSOR J. M. BRYANT, of the Department of Electrical Engineering of the University of Illinois, has recently served the City of Barry, Ill., as consulting engineer in connection with a proposed municipal electric power plant.

MINERAL POINT, WIS., WILL CONSTRUCT a new power plant in the spring, made necessary by the increasing demand for electric service. The building will be of steel, brick and iron, equipped with the newest machinery.

SAN DIEGO, Calif., is planning for an exposition and expects to have the buildings ready by July 1 next. The work on the main group is some 9 weeks ahead of schedule and 85 per cent of grounds and decorative gardens is completed. The exposition is to open in the fall.

THE THIRD ANNUAL GAS POWER SHOW is to be held in the Terminal Building, Toledo, Ohio, Oct. 19 to 24. A diagram of the exhibit spaces and terms for space, and regulations in regard to exhibits, may be obtained from H. R. Brate, Lakemont, N. Y.

EDWIN M. HALL, for many years treasurer of the Jefferson Union Co., Lexington, Mass., died on Feb. 11. The sterling worth of Mr. Hall has been felt by all with whom he was associated, and the announcement of his death is received with great sorrow.

WILLIAM G. MCADOO, Secretary of the Treasury, has appointed J. L. Stillwell, a consulting engineer of New York City, to assist the government architects in making plans for a $1,500,000 power plant for the use of the Federal buildings in Washington. He will be paid from an appropriation of $35,000 for outside experts, provided by Congress.

ON SATURDAY EVENING, Feb. 21, the employes of the Westinghouse Electric & Mfg. Co., who have been in its employ for a period of 20 yr. or more, held a meeting and organized the Veteran Employes' Association of the Westinghouse Electric & Mfg. Co. A striking fact was the youthful appearance of these so-called veterans, as the majority of the crowd appeared to be men in the prime of life. About 325 employes of the company are eligible to membership, and approximately 315 of these were present at this meeting. Mr. Guy E. Tripp, Chairman of the Board of Directors, was present and was elected as honorary member of the association, as was also Mr. Herr, neither of these gentlemen having been connected with the company the required number of 20 yr. A standing toast was drunk to Geo. Westinghouse, who was unable to be present on account of illness.

Catalog Notes

PITCHING IN! is the title of the latest circular from American School of Correspondence, Chicago.

FROM THE Lagonda Mfg. Co., Springfield, Ohio, comes an 18-page pamphlet describing and illustrating Lagonda automatic cutoff valves.

A CIRCULAR illustrating the new Model Star valve with regrindable, renewable disc, made by The Wm. Powell Co., of Cincinnati, has just been received.

BOOKLET A C 7, on the Gardner vertical air compressor, especially adapted for the automobile garage, was lately received from The Gardner Governor Co., Quincy, Ill.

RELATIVE CORROSION of wrought iron and steel is discussed in a pamphlet which quotes from various authorities relating to the subject. This pamphlet may be obtained by addressing Reading Iron Co., Reading, Pa.

LIST OF PRODUCTS has been compiled by National Tube Co., Pittsburgh, Pa., and issued in the form of "National" Bulletin No. 19, supplying a quick and ready reference to the products of the company, who will be glad to send copies to readers at their request.

PIONEERS, a booklet from Wagner Electric Mfg. Co., St. Louis, Mo., touches upon the history of the foremost of those who have made the present age of electricity possible. It also calls attention to some results of the work done by Wagner Electric Mfg. Co.

Bulletin 103, from the same company, shows a number of installations of the Wagner single-phase converter.

MOTOR-DRIVEN Refrigerating and Ice-Making Machinery (Section 3133), issued by the Westinghouse Electric & Mfg. Co., describes the process employed in this class of work and illustrates the application of electric motors thereto. A number of interesting installations are shown and a curve is given from which the horsepower required for different tons capacity machines can be determined. There is also included a table showing the type, capacity, and speed of motors required for the different machines in a refrigerating plant, together with the kilowatt-hours consumption. These tables are compiled for several different plants.

BULLETIN NO. 57, The Phenix Sight Flow Indicator, recently issued by The Richardson-Phenix Co., of Milwaukee, Wis., illustrates and describes how this device can be inserted in any pipe line carrying a liquid, such as water lines of water-cooled transformers and the supply pipes of water jackets of gas engines and air compressors, and how it shows at a glance or indicates electrically by lighting a lamp or ringing a bell when the flow of liquid is interrupted. Several recent improvements in the sight flow indicator are also described, showing how it is now possible to adjust the indicator so that it will give an alarm before the liquid stops flowing entirely—that is, when it drops to some predetermined minimum. This improvement has made it especially suitable for use on water-cooled transformers. Copies of the bulletin may be had by addressing the company as above.

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Trade-mark, Reg. U. S. Pat. Off.
SEMI-MONTHLY
PUBLISHED ON THE FIRST AND FIFTEENTH OF EACH MONTH
Subscription price in advance in the United States, Mexico or united possessions, $1.00 a year.
In Canada, subscription price, $1.75 a year.
Foreign Countries, subscription price, $2.50 a year.
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Wanted

IF YOU RECOGNIZE the value of approved specialties in an engine and boiler room as a means of higher efficiency; if you believe in this sort of thing to the extent that you think you could sell a well-known boiler specialty in your territory for an old-established manufacturer in the power-plant field, write and tell us all about yourself. On receipt of your letter we will outline our proposition in full. Address Box 324, Practical Engineer. tf.

WANTED—Every local Engineers' Association to have an assortment of valuable power-plant books—Secretary, write at once, for full particulars. Address Dept. C., Practical Engineer, Chicago.

IF YOU ARE a night engineer, spend a few hours each day taking subscription for Practical Engineer. You will be paid well. Write Subscription Dept. They will start you in at once.

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WANTED—ALL STEAM USERS to have clean boilers without using compounds or chemicals in any form. Write "Otis," No. 317 Norfolk Ave., Buffalo, N. Y. tf.

WANTED—Secretary of local Engineers' Association to write at once in regard to a very interesting proposition. Address Practical Engineer, Circulation Department.

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WANTED ENGINEER—Experienced waterworks engineer to take charge of power station. Fuel, natural gas; 8-hour shifts. Pumping 3,000,000 gallons daily. Centrifugal and plunger pumps used. Population, 16,000. Salary, $1,200.00 per annum. Also an assistant engineer for the same plant. Salary, $900.00 per annum. Positions open about April 15, 1914. State which position you apply for, age and experience. Box 596. Clarksburg, W. Va. 3-15-1

WANTED—An additional subscription solicitor wanted to cover towns in the State of Indiana. Excellent chance to earn extra money. Write to Subscription Department. tf.

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FOR SALE—250-VOLT, D.C. UNITS—25-kw. Sturtevant with Sturtevant Marine engine, $550. 30-kw. Ft. Wayne with Skinner engine, $600. Two 75-kw. Crocker-Wheeler with Harrisburg engines, $1200. 150-kw. Western Electric with Watertown engine, $1450. Duzets & Son, 50 Church St., New York. Send for complete "Bargain List." 3-1-2

USE AN AIR-FRICTION with new 1914 improvements. Increases power and economy of motor one-half. Absolutely impossible to choke or load. Uses distillate, gasoline or half kerosene with finest results. Starts easy in coldest weather. We fit all motors, guaranteeing definite results or refund money. Exclusive county rights. Liberal exchange on other carburetors. The Air-Friction Carburetor Co., Dayton, Ohio. 2-15-6

FOR SALE—Two 250-kw. Rotary Converters, type E. C., form E, class 6-250-500, 500 r.p.m., 600 volts, d.c.; d.c. amperes 416; a.c. end, 25 cycles, 3 phase, 360 volts. These machines are in A-1 condition and can be delivered at once. Price, $1,400 each, f.o.b. cars (Penna. delivery). F. H. Herring, Inc., 30 Church St., New York. 2-15-6

OUR MODERN BLUE PRINT CHART method of electrical wiring. Write for information. Electrical Wiring Diagram Co., Box F173, Altoona, Pa. 11-15-12

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Miscellaneous

ENGINEERS—DO YOU WANT to utilize your exhaust steam for heating or drying purposes, without back pressure on your engine? If so, address Monash Engineering Co. 1413 W. Jackson Blvd., Chicago, Ill. tf.

MAKE MONEY on the side. Here's your chance to work out some money for yourself. Get subscriptions for Practical Engineer. It pays well. Just drop a line to the Subscription Dept. They will tell you. tf.

EXTRA MONEY for a little spare time can be easily made by every engineer who is troubled with boiler scale or corrosion. Write T. K. McCarter, Temple, Texas. 3-15-1

Sparks From The Advertising Pages

We told you in the last issue how advertising has lowered the selling cost of a product; how it is the most economical method by which the manufacturer can talk and market to you.

Professor Walter Dill Scott, a noted authority on advertising, in his article, "The Social Service of Advertising," published in The Rollins Magazine, says:

> "We have largely solved our problems of production and manufacture, but our problem of distribution is with the future. The cost which is added to the product, after it leaves the producer or manufacturer, and before it reaches the ultimate consumer, is so enormous that it would seem no people could continue to pay it year after year and not become impoverished. One single item in the distribution of merchandise is general advertising. America's annual contribution to such advertising is commonly estimated at $600,000,000. It has been stated by various advertising experts that much of this advertising is so unwisely done, that three-fourths of it, or $450,000,000, is annually lost.
>
> "The annual expense for traveling salesmen is said to approximate $1,600,000,000, or $1,000,000,000 more than for general advertising. It is possible that if advertising were sufficiently well done, the number of traveling salesmen could be decreased so that the expense for such salesmen would be reduced to $600,000,000 annually—that is to say—the expense of traveling salesmen would be made equal to the amount now expended annually for advertising. This economy alone would save the American people one billion dollars annually. Such an amount, if spent for food, and applied to the right places, would probably be sufficient to drive want from the home of every needy family in America. Every dollar squandered in distribution is lost to the ultimate consumer. On the other hand, the ultimate consumer receives the benefit from every dollar that is wisely spent on advertising, because efficient advertising is the most economical form known of distributing merchandise."

Concerning the question, "Who pays for the advertising?" Mr. R. O. Eastman, of the Kellogg Toasted Corn Flake Company, Battle Creek, Michigan, writes, in a recent issue of Printers' Ink:

> "The 'cost of advertising' is merely one of the items of the cost of selling, and it is the cheapest method that a large producer can employ to sell his goods. Advertsing is a wonderful force, the economics of which are not yet clearly understood. It has created entirely new channels of merchandising. It has made it possible for the manufacturer to carry his story—his selling argument—direct to the consumer. * * *
>
> "If the question, 'Who pays for the advertising?' comes up for consideration, we need only point out that some six years ago we were making a package one-third smaller and selling it for fifteen cents. Today, after spending two or three million dollars in advertising the product, we are selling a package fifty per cent larger than the original package at a third less, or if you will figure it out, giving the consumer just twice as much for his money."

* * * * *

The manufacturers who advertise in Practical Engineer do so because through this publicity they are reducing the selling costs of their products.

In reading their advertisements, you are increasing your buying knowledge, and through purchasing advertised goods, you are contributing your per capita of effort to the general movement for reduction of selling costs.